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ESSAYS IN THE EMPIRICAL ANALYSIS OF VENTURE CAPITAL AND ENTREPRENEURSHIP

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EXECUTIVE SUMMARY

This thesis aims at analysing some aspects of Venture Capital (VC) and high-tech entrepreneurship. The focus is both at the macroeconomic level, comparing venture capital from an international point of view and Technology-Based Small Firms (TBSF) at company and founder's level in Belgium. The approach is mainly empirical.

This work is divided into two parts. The first part focuses on venture capital. First of all, we test the impact of VC on productivity. We then identify the determinants of VC and we test their impact on the relative level of VC for a panel of countries.

The second part concerns the technology-based small firms in Belgium. The objective is twofold. It first aims at creating a database on Belgian TBSF to better understand the importance of entrepreneurship. In order to do this, a national survey was developed and the statistical results were analysed. Secondly, it provides an analysis of the role of universities in the employment performance of TBSF.

A broad summary of each chapter is presented below.

PART 1: VENTURE CAPITAL

The Economic Impact of Venture Capital

The objective of this chapter is to perform an evaluation of the macroeconomic impact of venture capital. The main assumption is that VC can be considered as being similar in several respects to business R&D performed by large firms. We test whether VC contributes to economic growth through two main channels. The first one is innovation, characterized by the introduction of new products, processes or services on the market. The second one is the development of an absorptive capacity. These hypotheses are tested quantitatively with a production function model for a panel data set of 16 OECD countries from 1990 to 2001. The results show that the accumulation of VC is a significant factor contributing directly to Multi-Factor Productivity (MFP) growth. The social rate of return to VC is significantly higher than the social rate of return to business or public R&D. VC

has also an indirect impact on MFP in the sense that it improves the output elasticity of R&D. An increased VC intensity makes it easier to absorb the knowledge generated by universities and firms, and therefore improves aggregate economic performance.

Technological Opportunity, Entrepreneurial Environment and Venture Capital Development

The objective of this chapter is to identify the main determinants of venture capital. We develop a theoretical model where three main types of factors affect the demand and supply of VC: macroeconomic conditions, technological opportunity, and the entrepreneurial environment. The model is evaluated with a panel dataset of 16 OECD countries over the period 1990-2000. The estimates show that VC intensity is pro-cyclical - it reacts positively and significantly to GDP growth. Interest rates affect the VC intensity mainly because the entrepreneurs create a demand for this type of funding. Indicators of technological opportunity such as the stock of knowledge and the number of triadic patents affect positively and significantly the relative level of VC. Labour market rigidities reduce the impact of the GDP growth rate and of the stock of knowledge, whereas a minimum level of entrepreneurship is required in order to have a positive effect of the available stock of knowledge on VC intensity.

PART 2: TECHNOLOGY-BASED SMALL FIRMS

Survey in Belgium

The first purpose of this chapter is to present the existing literature on the performance of companies. In order to get a quantitative insight into the entrepreneurial growth process, an original survey of TBSF in Belgium was launched in 2002. The second purpose is to describe the methodology of our national TBSF survey. This survey has two main merits. The first one lies in the quality of the information. Indeed, most of national and international surveys have been developed at firm-level. There exist only a few surveys at founder-level. In the TBSF database, information both at firm and at entrepreneur-level will be found.

The second merit is about the subject covered. TBSF survey tackles the financing of firms (availability of public funds, role of venture capitalists, availability of business angels,…), the framework conditions (e.g. the quality and availability of infrastructures and communication channels, the level of academic and public research, the patenting process,…) and, finally, the socio-cultural factors associated with the entrepreneurs and their environment (e.g. level of education, their parents' education, gender,…).

Statistical Evidence

The main characteristics of companies in our sample are that employment and profits net of taxation do not follow the same trend. Indeed, employment may decrease while results after taxes may stay constant. Only a few companies enjoy a growth in both employment and results after taxes between 1998 and 2003.

On the financing front, our findings suggest that internal finance in the form of personal funds, as well as the funds of family and friends are the primary source of capital to start-up a high-tech company in Belgium. Entrepreneurs rely on their own personal savings in 84 percent of the cases. Commercial bank loans are the secondary source of finance. This part of external financing (debt-finance) exceeds the combined angel funds and venture capital funds (equity-finance).

On the entrepreneur front, the preliminary results show that 80 percent of entrepreneurs in this study have a university degree while 42 percent hold post-graduate degrees (i.e. master's, and doctorate). In term of research activities, 88 percent of the entrepreneurs holding a Ph.D. or a post-doctorate collaborate with Belgian higher education institutes. Moreover, more than 90 percent of these entrepreneurs are working in a university spin-off.

The Contribution of Universities to Employment Growth

The objective of this chapter is to test whether universities play a role amongst the determinants of employment growth in Belgian TBSF. The empirical model is based on our original survey of 87 Belgian TBSF. The results suggest that both academic spin-offs and TBSF created on the basis of an idea originating from

business R&D activities are associated with an above than average growth in employees. As most 'high-tech' entrepreneurs are at least graduated from universities, there is no significant impact of the level of education. Nevertheless, these results must be taken with caution, as they are highly sensitive to the presence of outliers. Young high-tech firms are by definition highly volatile, and might be therefore difficult to understand.

CONCLUSION

In this last chapter, recommendations for policy-makers are drawn from the results of the thesis. The possible interventions of governments are classified according to whether they influence the demand or the supply of entrepreneurship and/or VC. We present some possible actions such as direct intervention in the VC funds, interventions of public sector through labour market rigidities, pension system, patent and research policy, level of entrepreneurial activities, bankruptcy legislation, entrepreneurial education, development of university spin-offs, and creation of a national database of TBSF.

Working Papers and Publications

This dissertation is based on the work contained in the following papers. Each chapter however presents further developments and empirical results.

Paper 1

ROMAIN A. and B. VAN POTTELSBERGHE (2004) « The Economic Impact of Venture Capital », *Deutsche Bundesbank Discussion Paper Series 1*: Studies of the Economic Research Centre No 18/2004, 31 p.
(Submitted for publication)
(http ://www.bundesbank.de/download/volkswirtschaft/dkp/2004/200418dkp.pdf)

Paper 2

ROMAIN A. and B. VAN POTTELSBERGHE (2004) « The Determinants of Venture Capital: Additional Evidence », *Deutsche Bundesbank Discussion Paper Series 1*: Studies of the Economic Research Centre No 19/2004, 32 p.
(Submitted for publication)
(http ://www.bundesbank.de/download/volkswirtschaft/dkp/2004/200419dkp.pdf)

Paper 3

BOZKAYA A., A. ROMAIN and B. VAN POTTELSBERGHE (2003) « Surveying Technology-Based Small Firms: A Perspective From Belgium », *Institute of Innovation Research (IIR) Working Paper*, n°03-23; Hitotsubashi University (Japon).
(http://www.iir.hit-u.ac.jp/file/WP03-23bruno.pdf)

Paper 4

ROMAIN A. and B. VAN POTTELSBERGHE (2005) « On the Relationship between Patents and Venture Capital », chapter 10, *Economics and Management Perspectives on Intellectual Property Rights*, Palgrave McMillan, edited by Peeters C. and B. Van Pottesberghe, Belgium, pp 222-237.

Paper 5

ROMAIN A. (2006) « From idea's to job Creation? The empirical challenge of assessing the contribution of universities to employment growth », Brussels Economic Review (forthcoming).

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CHAPTER 1:

INTRODUCTION

1.1. The role of venture capital and entrepreneurship

In the 1970s and the 1980s, an increasing part of economic growth switched from large firms to small firms (Wennekers and Thurik, 1999). Since the 1980s a lot of attention has been directed to small business and entrepreneurship. Many economists and politicians seem to agree that entrepreneurship has become the engine of economic and social development throughout the world. According to some studies like the one of Audretsch and Thurik (1999), an increase in the rate of entrepreneurship leads to lower levels of unemployment.

The European commission is also convinced that European SMEs are one of the key to deliver stronger growth and more jobs. The Lisbon European Council (2000) set the objective of making Europe the most competitive and dynamic knowledge-based economy in the world by the year 2010. The Lisbon process also aims at making Europe a more attractive place to invest in R&D. Therefore, European countries have to boost the entrepreneurial initiative and to create a productive environment where innovation capacity can grow and develop.

The European Commission also want to promote a bigger Venture Capital (VC) industry in the EU so as to better compete with the United States in creating new

firms to boost employment and growth (see for example the Innovation and Technology Equity Capital pilot project[1]). Indeed, there are large differences between American and European entrepreneurship. It is commonly accepted that the United States, on the one hand, offer a favourable environment to the development of entrepreneurial activities. The market size and the deregulation of high-tech and innovation enterprises are very important determinants of US entrepreneurial activities. In Europe, on the other hand, the development of high-tech companies has been more modest in the recent years. According to Bloch (2000), several paradoxes can explain the low level of European entrepreneurial activities when compared to the United States. For example, governments intervene more often on the labour market than in the United States. For Bloch, the predominant social model in Europe, with rigid rules of employee protection, seems to be the cause of lower entrepreneurial dynamics. Moreover, another difference between Europe and the United States concerns the way entrepreneurs handle the risk of failure. European entrepreneurial model could adopt some US best practices, taking however into consideration that copying US practices may inflict heavy social costs.

It seems to be important to develop favourable conditions in Europe. But experts do not agree on the process to do so. According to some, this process does not imply heavy money transfers to the creation of companies (Block, 2000). Others however believe that, under the hypothesis of market imperfections, governments have several ways at their disposal to intervene in the economic process (Grilo and Thurik, 2004). The concluding chapter will present some of them.

Research objectives

The objective of this thesis is to shed light on some aspects of the role of entrepreneurship on economic growth and on employment. We research three main

[1] Launched in 1997, the Innovation and Technology Equity Capital (I-TEC) pilot project is an initiative of the European Commission to encourage early stage investments in technologically innovative SMEs. Thanks to this pilot project, innovative SMEs can access a network of 28 capable Venture Capital investors, interested in business projects with a high degree of innovation in technology, product, service or process and with a high potential for growth and new job creation.

questions. Firstly, we concentrate on the impact of the stock of high-risk finance on the productivity of OECD countries in order to analyse to what extent VC contribute to economic growth. As the results seem to show that VC can effectively be considered as an additional factor explaining variations in economic performance of a country, a second question appears: why the relative VC investments vary substantially across countries? Therefore, we secondly investigate the reasons that explain this heterogeneity between countries. We estimate the impact of the entrepreneurial environment and of the technological opportunities on a country's intensity in VC.

Finally, the second part of this thesis focuses on the growth in Belgian Technology-Based Small Firms (TBSF). More specifically, the last chapter assesses the role of universities in the development of employment in Belgian TBSF. Indeed, in addition to the economic growth analysed in the first part of this thesis, the employment issue is also at the heart of concerns for a lot of European countries.

The concept of entrepreneurship

The concept of entrepreneurship in this dissertation takes inspiration in different definitions. Indeed, when studying entrepreneurial activities, academic researchers have proposed a broad array of definitions and measures. The absence of a unique definition comes from the fact that entrepreneurship is a multidimensional, complex, social, psychological and economic concept. Hence, the research on this topic can be found in various domains such as, for example, labour economics, economics of education, and industrial economics.

The modern definition of entrepreneurship was introduced by Schumpeter in 1934. According to Schumpeter, managers of already established businesses are not entrepreneurs. The entrepreneur is defined as the innovator who implements change within markets by carrying out new combinations. This process may come in several forms: the introduction of a new good or quality thereof, the introduction of a new method of production, the opening of a new market, the conquest of a new source of supply of new materials or parts, and/or the carrying out of the new organisation of any industry.

Based partly on Schumpeter's definition, Carton, Hofer and Meeks (1998) present entrepreneurship as the pursuit of a discontinuous opportunity involving the creation

of an organisation (or sub-organisation) with the expectation of value creation to the participants. The entrepreneur is the individual who (or team that) identifies the opportunity, gathers the necessary resources, creates and is ultimately responsible for the performance of the organisation. Therefore, entrepreneurship is the means by which new organisations are formed with their resulting job and wealth creation.

Another possible definition is the one by Wennekers and Thurik (1999). According to them, entrepreneurship could be defined as the willingness of individuals - on their own, in teams, within and outside existing organisations - to perceive and create new economic opportunities (new products, new production methods, new organisational schemes and new product-market combinations), and to introduce their ideas in the market, in the face of uncertainty and other obstacles, by making decisions on location, form and the use of resources and institutions.

This thesis defines entrepreneurship as the creation of new companies with an emphasis on the innovation aspect, which can take different forms such as new product, new process, and/or new market. Entrepreneurship is indeed a key to accelerate the creation, dissemination and development of innovation. Even if entrepreneurship in the United States is not only based on high-technologies and innovation, it is a highly debated issue in the description of the American model (Hellman, 2000). According to Schumpeter (1934), "The function of entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention, or more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way".

TBSF were chosen as a base for our analyses because as long as they survive and develop, they may drive the future economic performance of countries. In fact, TBSF are amongst companies with the highest growth potentials on the middle and long run (Weigand and Audretsch, 1999). Certain new and innovative companies in more traditional non high-tech industrial sectors may also benefit from high employment growth. However, these companies generate less positive externalities to the rest of the economy. High-tech companies generate knowledge, competence and a demand for quality services and intermediate products that have significant repercussions on the rest of the economy. Moreover, they are able to establish and maintain relationships with universities and research laboratories, sources of future innovation.

For the purpose of empirical studies in this thesis, two main elements are used to define technology-based activities. The first is the high-tech character of the firms' activities. We therefore focus on companies operating in sectors defined as high-tech and medium-high-tech in the OECD classification. The second type of activities relate to academic research. Hence, we include all university spin-offs.

1.2. Structure of the thesis

The objective of this dissertation is to shed light on three questions regarding entrepreneurship: the effect of VC on economic growth, the reason of the observed heterogeneity in VC across countries, and the employment growth in TBSF. As outlined in the Table 1.1, these three questions condition the structure of the thesis.

The first part of the thesis focuses on VC as an important factor underlying the creation and development of TBSF. Indeed, VC funds are made available for start-up firms and small businesses with exceptional growth potential. Managerial and technical expertise is also often provided. Access to finance is seen as a key factor in the process of R&D's translation into commercial outcomes. VC, as a specific type of finance for high-risk projects, has an important role to play in favouring the commercialisation of innovative products (OECD, 1996). Most government bodies in industrialised countries now recognise the importance of VC as a factor underlying firm creation and sustainable growth.

From the entrepreneur's point of view, VC represents a monetary resource, a financial intermediary aiming at satisfying the needs of innovative start-ups. TBSF are generally associated with large growth potentials and high levels of uncertainty. From the investor's point of view, investing in high-tech start-ups is very risky. Hence, notwithstanding the high variability of returns linked to this risky context, a venture capitalist selecting a successful project could expect very large returns. Therefore, the high volatility of returns is more than offset by the expectation of outstanding incomes.

Table 1.1: General outline of the dissertation

Chapter 1: Introduction

PART 1: Venture Capital

Chapter 2: The Economic Impact of Venture Capital

Question: What impact has the stock of high-risk finance on the productivity of an OECD country?

→ Does this VC stock have an impact on the absorptive capacity of R&D?

Chapter 3: Technological Opportunity, Entrepreneurial Environment and Venture Capital Development

Question: What explains the large differences in the VC intensity from a country to another?

→ What is the impact of the entrepreneurial environment of the country?

→ What is the impact of the technological opportunities?

PART 2: Technology-Based Small Firms

Chapter 4: Literature and Survey on TBSF

Chapter 5: Statistics of an Original Survey in Belgium

Chapter 6: The Contribution of Universities to Employment Growth

Question: What is the impact of universities in the development of employment in TBSF?

→ Is this impact concretized through the function of formation of the universities? Through its function of research centre or its function of creation of spin-offs?

Chapter 7: Concluding Summary and Policy Implications

Two main questions are addressed in the first part of this dissertation. Chapter 2 presents the first question that handles with the funding aspect of high-tech companies by analysing the impact of VC stock on productivity for a sample of OECD countries. We take the stock of VC as a proxy for entrepreneurial activity and we evaluate whether and to what extent, VC contributes to economic growth.

The second main question of this thesis is presented in chapter 3. This chapter studies the factors that explain the heterogeneity in VC intensity across OECD countries. More specifically, it evaluates the impacts of entrepreneurial environment and technological opportunity on the countries' VC intensity. In order to answer this question, we model the demand and supply of VC. Results show that entrepreneurial environment and technological opportunity contribute to explain a part of the VC intensity across OECD countries.

The second part of the thesis focuses on the technology-based small firms in Belgium. Its objective is to analyse the employment growth in high-tech small firms. We take the definition of high-tech companies presented above (i.e. high-tech and medium-high-tech companies as defined in the OECD classifications as well as university spin-offs) adding however another specification to the approach: the size of the companies. Indeed, we only focus on the small firms according to the European Union definition.

In order to get a quantitative insight into the entrepreneurial growth process in Belgium, a survey of TBSF was launched in 2002. The subjects addressed by the survey relate to three factors of entrepreneurial development: the framework conditions, the socio-cultural factors associated with the entrepreneurs and their environment, and the financial system. From a database including 607 companies that matched the criteria of small size and high-tech industry in 2002, 103 fully filled-in questionnaires were received, which represents a response rate of 17 percent. This allows us to gather a wealth of new and original information.

The last question of this work concerns the employment performance of Belgian TBSF. Several intermediate chapters are necessary before answering the main empirical question in chapter 6. Chapter 4 takes inspiration in the literature review in order to present the different possible measures of the development of entrepreneurial activities. This chapter also explores the method of the original survey carried out in Belgium on TBSF in order to build our quantitative analysis.

Chapter 5 presents descriptive statistical evidence on Belgian high-tech companies and their entrepreneurs. This chapter provides a first insight into the issue of TBSF in Belgium and presents evidence concerning companies' and entrepreneurs' characteristics, technology transfer and innovation, and financing. It describes the characteristics of the sample of high-tech companies, the technological transfers and innovation activities, the social and educational culture underlying entrepreneurship, the entrepreneurs' opinion on physical, social, commercial and professional infrastructure, with the aim of better understanding TBSF entrepreneurship, and finally the reasons and perceptions behind entrepreneurs' activities. Moreover it introduces the econometric study presented in the following chapter and describes some of the variables used in our empirical analysis.
Finally, chapter 6 handles the employment performance of TBSF by studying the contribution of universities to TBSF's employment growth. Our database actually gives us the necessary information to assess the role universities can play in the employment performance of firms through research, spin-off creation and education. This chapter contributes to the literature on the determinants of jobs creation in small technology-based firms. Firms' type (i.e. academic spin-off vs. start-up) and the origin of the innovative idea are included amongst the potential determinants of job creation.

The first section of the concluding chapter reviews the main findings and contributions emerging from the three questions asked in this work as well as some ideas for future research. In a second section, recommendations for policy-makers are drawn from the results.

PART 1: VENTURE CAPITAL

CHAPTER 2:

THE ECONOMIC IMPACT OF VENTURE CAPITAL

2.1. Introduction

Venture capitalists intervene as intermediaries in financial markets providing Venture Capital (VC) to small firms with high growth potential. Venture-funded firms are generally very small and young, often called "innovative start-ups", and are plagued by very high levels of business uncertainty and an important information asymmetry between investors and entrepreneurs (Gompers and Lerner, 2001a; Berger and Udell, 1998). The venture capitalists provide both financial support, i.e. equity to spur fast growth, and non-financial help such as management guidance and expertise (Sapienza, 1992). They may sit on boards of directors and may perform key corporate functions for the venture-backed companies or provide valuable governance and advisory support.

A growing number of empirical investigations outlines the crucial importance of VC for high-tech start-up growth (e.g. Timmons and Bygrave, 1986; Engel, 2002; Davila *et al.,* 2003), product marketing strategy (Hellemann and Puri, 2002) and survival (Manigart and Van Hyfte, 1999). The aggregate role of VC in the economy also begins to be an important area of research but very few quantitative investigations have been performed so far. At the aggregate economic level, Baumol (2002) argues, with a

theoretical model, that entrepreneurial activity may account for a significant part of the "*unexplained*" proportion of the historical growth of the Western nations' output[2].

The objective of this chapter is precisely to attempt to provide evidence of Baumol's conjecture. We take the stock of VC as a proxy for entrepreneurial activity and we evaluate whether and to what extent VC contributes to economic growth. We adopt the hypothesis that VC can be considered as being similar to experimental development activities performed in large firms, i.e. the "*D*" of R&D. In this respect, the contribution of VC would take place through two main channels: innovation (i.e. the effective introduction of new products and processes on the market), and absorptive capacity (i.e. the development of know-how and skills that induce an effective use of existing knowledge to improve the production system).

The chapter is structured as follows: the next section focuses on the existing literature about the potential effect of VC, at micro and macroeconomic levels. The empirical model and the data are described in the third section. Section four presents the econometric results. The final section concludes.

2.2. Existing investigations

A number of factual evidences on the economic impact of VC have been published by specialized institutions, especially for the US economy. According to a study carried out by DRI-WEFA[3] on US VC-funded companies over the period 1970-2000, "venture capital-backed companies had approximately twice the sales, paid almost three times the federal taxes, generated almost twice the exports, and invested almost three times as much in R&D as the average non-venture capital-backed public company, per each $1000 of assets" (NVCA, 2002). The same study also shows that VC fosters local and regional economic growth in the USA. During the period 2000-2003, Global Insight (2004) confirms the positive impact of VC-funds on employment, sales and wages of the VC-funded companies. Based on their own statistics, the European Venture

[2] Baumol (2002), pp. 58-59

[3] DRI-WEFA, now called Global Insight Inc., was formed to bring together the two well-respected economic and financial information companies, DRI (Data Resources Inc.) and WEFA (Wharton Econometric Forecasting Associates).

Capital Association studies (1996, 2001, 2002 and 2004) argue that VC has an impact on economic growth. According to EVCA, venture-backed companies stimulate the economy through the creation of jobs[4], their exceptional growth rate, their heavy investments and their international expansion. In addition, VC is thought to play a role in the substantial decrease of the required time to introduce an innovation on the market.

Empirical research on the impact of VC on firms' performance has been performed at the micro level. Hellmann and Puri (2000) implemented a survey of 149 recently formed firms in the *Silicon Valley*. Their empirical results suggest that VC stimulates innovative activities of firms. A start-up financed by a venture capitalist requires less time to bring a product to the market. They do also admit that firms pursuing an "innovator strategy"[5] potentially have better and quicker access to VC funds. Nevertheless, their results should be interpreted with caution since the authors face a problem of causality and geographical concentration of firms. Indeed, as far as the causality problem is concerned, it is possible that the more a firm is innovative, the more it applies for VC. In this sense, it is not the VC that would stimulate firms to be more innovative. The validity of these conclusions is also limited by the diversity of the sample, which 'only' includes *Silicon Valley* start-ups. For the authors, VC can have an impact on the technological trajectory of a start-up company, and in particular on its product market position. According to Gompers and Lerner (2001b), a simple model of the relationship between VC, R&D and innovation is likely to give misleading estimates because both venture funding and patenting could be positively related to a third unobserved factor - the arrival of technological opportunities.

Adopting a similar perspective, but relying on a panel dataset of about 1000 German start-ups, Engel (2002) shows that the surviving German venture-backed companies seem to achieve significant higher growth rates due to financial involvement and services provided by venture capitalists. The author also shows that the impact of VC

[4] For more details on the vital role played by VC in the creation of employment, see EVCA (2005), "Employment contribution of Private Equity and Venture Capital in Europe".

[5] Innovators are those firms that are the first to introduce new products or services for which no close substitute is yet offered on the market. Imitators are also engaged in relatively new products and technologies, but they are not the first movers in their markets, and therefore tend to compete on aspects other than innovation.

on new firms' growth rate does not differ between high-tech and low-tech industries. Hellmann and Puri (2002) also examine the additional role played by venture capitalists compared to traditional financial intermediation. The authors focus on the development of 170 young high-technology firms in *Silicon Valley*. They find that venture capitalists intervene in a wide number of activities that are important for the professionalization and the development of a start-up company (i.e. managerial advice, strategy formulation, communication skills, the formulation of human resources policies and the adoption of stock option plans etc.).

From a wider point of view, Kortum and Lerner (2000) perform an evaluation of the relation between VC and innovation. The authors examine the influence of VC on the propensity to patent inventions in the US from 1965 to 1992, with 20 industries and 530 venture-backed and non-venture-backed firms. Performing a wide variety of specifications, they find that VC activity significantly increases the propensity to patent, to a much larger extent than corporate R&D. They further show that, while from 1983 to 1992 the ratio of VC to R&D was on average smaller than 3%, VC may have accounted for 8% of industrial innovations during the same period. Tykvova (2000) provides further empirical validation of these results with German data.

The causality issue between VC and innovation is analysed by Engel and Keilbach (2002) who compare 142 venture-funded firms with more than 20 000 non venture-funded firms in Germany. Their analysis provides evidence on several levels. Firms with an innovative performance, proxied by a patent performance indicator, are able to benefit from venture funds with a higher probability. Once a start-up is venture funded, it shows higher employment growth rates but no significant difference in innovative output compared to non-venture funded firms.

The recent analysis of Ueda and Hirukawa (2003) also focuses on the causality issue of VC investments and innovation. They use Multi-Factor Productivity (MFP) growth as a measure of innovation in the US manufacturing industry. They find that MFP growth is significantly and positively associated with subsequent VC investments. Furthermore, they add that, in computer and communication sectors, VC has an impact on innovation and vice versa. On the other hand, in drugs and scientific instrument industries, they find that MFP growth and VC investment are often significantly and negatively related.

Audretsch and Keilbach (2003) perform an aggregate analysis and evaluate the impact of entrepreneurship capital on the economic performance of German regions. They use a Cobb-Douglas function of the following form $Y_i = \alpha K_i^{\beta_1} L_i^{\beta_2} R_i^{\beta_3} E_i^{\beta_4} e^{\varepsilon_i}$ where K represents the factor of physical capital, L represents labour, R represents knowledge capital, and E represents entrepreneurship capital. Their results indicate that entrepreneurship capital[6] is a significant and important factor shaping output and productivity. This chapter investigates the same causal relationship by using VC as a proxy of entrepreneurship capital.

In a nutshell, there is some evidence that VC and entrepreneurial activity foster innovative, patenting and growth performances, at least in the USA and Germany. Nevertheless, there is no formal evaluation of the impact of VC on aggregate economic growth and very few are the investigations carried out in other industrialised countries. In what follows, we attempt to evaluate the macroeconomic impact of VC in 16 OECD countries, over the period 1990-2001.

2.3. The empirical implementation

2.3.1. The model

Our basic hypothesis is that VC investment is somewhat similar, in its nature and function to the experimental development mainly performed by large firms – the "*D*" of R&D. According to the definition of the OECD Frascati Manual (2002), *Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.* More precisely, this definition can be divided into 3 types of R&D: basic research, applied research, and experimental development. *Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Applied research is also original investigation undertaken in*

[6] The entrepreneurial capital is proxied by the number of start-ups in a region, relative to its population.

order to acquire new knowledge. Applied research is, however, directed primarily towards a specific practical aim or objective. Finally, experimental development is systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed. This third definition of R&D is quite similar to the activities that are performed in small innovative companies. This idea is somewhat supported by Tykvova (2000), who argues that large and established companies may be less innovative than young small firms. This is due to their structure and internal organization. New companies with pioneering ideas and with a flexible structure can react to the concerns of the customers more appropriately. Tykvova argues that VC can solve the lack of capital and managerial experience that young and innovative firms face. Indeed, venture capitalists share their experiences with the managers of firms they finance in order to stimulate the transformation of inventions into new products and processes.

Moreover, the OECD Frascati Manual (2002) specifies that R&D is not the only way to introduce new products or process. According to this manual, the acquisition of patents and special equipment, the training of workforce with the necessary skill… may also be considered as innovative activities. Since VC is a source of funds for risky new companies and since venture capitalists may give important advice to firms, it seems legitimate to assume that VC is a key engine for these companies. In other words, because VC improves the performance of new firms, it can be considered as a major determinant of economic growth. To this regard, Baumol (2002) also argues that entrepreneurial activity may account for a significant part of the "*unexplained*" proportion of the historical growth of Western nations' output (pp. 58-59). Audretsch and Keilbach (2003) test this impact of entrepreneurial activity on economic performance. In this chapter, we would like to test the same assumption for OECD countries and we take VC stock as a proxy for the entrepreneurial activity carried out within each country.

Beside the first direct effect, VC exerts an indirect effect on companies' performance. The ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical for the firm's innovative capabilities (Cohen and Levinthal, 1990). Venture funded activities can be assimilated to intensive learning processes. We therefore assume that it allows developing a rapid and effective

absorptive capacity of outside knowledge. The contribution of VC to aggregate productivity growth can therefore be evaluated through two main mechanisms. The first one would be the direct contribution of VC to productivity growth induced by the creation of new products and processes. The second mechanism would act through the development of the firm absorptive capacity.

In order to test the assumption that VC is a determinant of economic growth, we use VC as an additional source of knowledge in a traditional knowledge production function. Various sources of technical change are therefore taken into account including business and public R&D capital stocks, and a stock of VC. Business-cycle effects that strongly influence productivity in the short run are also included as 'control' variables.

The model, on which the estimated equation is based, is a traditional Cobb-Douglas production function. The Hicks-neutral production[7] function can be written as:

$$Y = F(K, L, t) = T(t) \times F(K, L) \qquad (2.1)$$

Where Y is the flow of output produced at time t, L and K are measures of labour and capital inputs, respectively, $T(t)$ is an index of the state of the technology, and $T(t) \geq 0$.

$$T(t) = G(R, VC, O) \qquad (2.2)$$

Where R is the measure of accumulated research capital (as a proxy of the stock of knowledge), VC is the measure of accumulated venture capital, and O stands for the other forces affecting productivity (among which disembodied technical change).

$$R_t = \sum w_h I^R_{t-h} \qquad (2.3)$$

Where R is the measure of accumulated research capital, I^R measures gross R&D expenditures in period t, and w_h connects the level of past research to the current state of knowledge.

$$VC_t = \sum w_h I^{VC}_{t-h} \qquad (2.3')$$

[7] Technology is implicitly assumed to be output-augmenting (Hicks-neutral) instead of labour-augmenting (Harrod-neutral). In fact, there is no reason to prefer a labour-augmenting or a capital-augmenting technology as we assume that technology may well have an impact on both labour and capital.

Where VC is the measure of accumulated venture capital, I^{VC} measures gross VC investments in period t, and w_h connects the level of past VC to the current state of VC.

The Cobb-Douglas production function of a country i can be written as follows:

$$Y_i = \exp\left[\phi_i t + \mu_i\right] L_i^{\alpha_1} K_i^{\alpha_2} R_i^{\beta} VC_i^{\gamma} \qquad \text{with } i = 1,...,n \qquad (2.4)$$

Where O is approximated by an exponential trend $(t), \phi$ is the disembodied technical change, μ is a random term and α_1, α_2, β and γ are respectively the output elasticities of labour, capital, R&D capital stock and VC capital stock.

The natural logarithm (L) of Equation 2.4 is:

$$LY_i = \phi_i t + \alpha_1 LL_i + \alpha_2 LK_i + \beta LR_i + \gamma LVC_i + \mu_i \qquad (2.5)$$

From Equation 2.5, we derive an index of the state of technology (multi-factor productivity -MFP):

$$LT(t) = LY_i - \hat{\alpha}_1 LL_i - (1-\hat{\alpha}_1) LK_i = \phi_i t + \beta LR_i + \gamma LVC_i + \mu_i \qquad \text{with } \alpha_2 = (1-\alpha_1) \qquad (2.6)$$

The above equation requires the assumption of constant returns to scale with respect to labour, capital and the payment of these traditional inputs (i.e. a perfect competition environment). Therefore, the output elasticities with respect to labour (capital) are assumed to be equal to the labour (capital) cost share in total output and α_2 is equal to $(1-\alpha_1)$.

As you can see in the following section, for the purpose of our empirical study, we separate the various sources of technical change: domestic R&D, public R&D and the VC. We also include times dummies, and two control variables.

2.3.2. Construction of the data

Index of the state of the technology T(t)

MFP is an index of multi-(total)-factor productivity. This has been computed in the usual way (OECD, 2001), as the ratio of the domestic product of industry on the weighted sum of the quantity of labour and fixed capital stock, the weights being the annual labour cost share and the capital cost share respectively (under assumptions of perfect competition and constant return to scale). The series come from the OECD National Accounts database.

It must be noticed that Ueda and Hirukawa (2003) use the MFP-index as a proxy for innovation. In this chapter, we investigate to what extent various sources of knowledge, including VC, contribute to this index of technical change.

R&D capital stock

SBRD is the domestic business R&D capital stock and ***SPRD*** is the public R&D capital stock, which includes R&D expenditures performed in the higher education sector and in the government sector (public laboratories). The series come from the OECD Main Science and Technology Indicators.

The R&D capital stocks have been computed using the perpetual inventory method from total intramural R&D expenditures, in constant 1990 GDP prices and US Purchasing Power Parity-PPP. The stock at time *t* is equal to the new investment at time *t* plus the stock at time *t-1* minus depreciation:

$$R_t = \sum w_h I^R_{t-h} \qquad (2.3)$$

$$SRD_t = rd_t + (1-\delta)\, SRD_{t-1} \qquad (2.3.1.)$$

$$SRD_t = rd_t + (1-\delta)\, rd_{t-1} + (1-\delta)^2\, rd_{t-2} + (1-\delta)^3\, rd_{t-3} + ... \qquad (2.3.2.)$$

To construct the initial stock we assume a constant annual rate of growth of the past investments,

$$SRD_t = rd_t + (1-\delta)\, \lambda\, rd_t + (1-\delta)^2\, \lambda^2\, rd_t + (1-\delta)^3\, \lambda^3\, rd_t + ... \qquad (2.3.3.)$$

$$SRD_t = \frac{rd_t}{1-\lambda\,(1-\delta)} \qquad (2.3.4.)$$

where SRD_t = R&D capital stock at time t.

rd_t = R&D investment at time t.

δ = Depreciation rate (constant over time).

$\lambda = \frac{1}{1+\eta}$ and η is the mean annual rate of growth of rd_t.

The same formula has been used to calculate the Business R&D Capital Stock (*SBRD*) and Public R&D Capital Stock (*SPRD*). The depreciation rate is 15% for the two variables. Guellec and van Pottelsberghe, (2001 and 2004) use the same R&D data and make sensitivity analyses which demonstrate that the results of the regressions do not change significantly with respect to the depreciation rate.

Business R&D capital stock is used as the proxy of knowledge capital at the beginning of the period. Therefore, Business R&D capital stock has a one-year lag in the model.

Since public R&D activities are not performed by the business sectors, we expect a longer delay than one year before they affect business productivity and therefore include them in the model with a two-year lag[8].

Venture capital stock

SVC is the stock of domestic venture capital. It has been computed, as for R&D capital stocks, using the perpetual inventory method from all types of venture investments by country[9], in constant 1990 GDP prices and US PPP. The series come from the EVCA and the OECD.

$$VC_t = \sum w_h I^{VC}_{t-h} \qquad (2.3')$$

$$SVC_t = vc_t + (1-\delta)\, SVC_{t-1} \qquad (2.3'.1.)$$

$$SVC_t = vc_t + (1-\delta)\, vc_{t-1} + (1-\delta)^2\, vc_{t-2} + (1-\delta)^3\, vc_{t-3} + ... \qquad (2.3'.2.)$$

To construct the initial stock we assume a constant annual rate of growth of the past investments,

$$SVC_t = vc_t + (1-\delta)\, \lambda\, vc_t + (1-\delta)^2\, \lambda^2\, vc_t + (1-\delta)^3\, \lambda^3\, vc_t + ... \qquad (2.3'.3.)$$

$$SVC_t = \frac{vc_t}{1-\lambda(1-\delta)} \qquad (2.3'.4.)$$

where SVC_t = VC capital stock at time *t*.

vc_t = VC investment at time *t*.

δ = Depreciation rate (constant over time).

$\lambda = \frac{1}{1+\eta}$ and η is the mean annual rate of growth of vc_t.

[8] The same specification with different lags (i.e. three- and four-year lags) has been tested. It led to similar results.

[9] Total investments by country are both private and public funds. Some additional information is available for a part of the initial sample: decomposition by type of funds and even by stage of development of the financed company. However, for our purpose, a larger geographic coverage with aggregated data, has been preferred to more precise data on a limited sample.

We have included a table (Table A.2.1.) with the various multiplicators λ, calculated for each depreciation rate in the Appendix 9.1, page 174.

It is extremely difficult to find aggregated data on VC activities. Moreover, these datasets often contain serious errors. Indeed, the industry may overstate its role in order to get wider recognition. For example, many deals may be classified as VC instead of leverage buy-outs (LBOs)[10].

The majority of the data used in the first part of the thesis, comes from the European Venture Capital Association (EVCA). We tried to find a non-trivial amount of VC provided by national governments but these amounts are difficult to compare between countries. We know that EVCA definition of VC is not exactly the same as the US one. It includes management buy-outs (MBOs)[11] and management buy-ins (MBIs)[12]. Therefore, although we know that private equity finance in buy-outs may also be associated with innovative activity (EVCA, 2001a), in the present analysis, and in order to have homogenous definition of VC, venture expenditures include only seed, start-up and early stage capital and do not include replacement capital and buyout.

Since VC is a highly risky investment and since VC concerns more development than basic research, the VC stock is rapidly depreciated. Therefore, we rely on a high depreciation rate to compute the stock of VC. The annual depreciation rate retained is 30%. We have carried out sensitivity analyses showing that the regression results do

[10] Leverage buy-out (LBO) is a strategy involving the acquisition of another company using borrowed money (bonds or loans). The acquiring company uses its own assets as collateral for the loan while hoping that the future cash flows will cover the loan payments.

[11] Management buy-out (MBO) occurs when the managers and/or the executives of a company purchase from existing shareholders a controlling interest in the company. In most cases, the management will buy out all the outstanding shareholders and then take the company private because it feels it has the expertise to grow the business better if it controls the ownership. Quite often, management will team up with a venture capitalist to acquire the business because it's a complicated process, requiring significant amount of capital.

[12] Management buy-in (MBI) refers to a group of investors outside a company purchases a controlling block of shares, while keeping the existing management. The investors involved in the MBI believe that the company and its current management are of great value. A few representatives from the group of investors will usually be appointed to the company's board of directors.

not change significantly with the chosen depreciation rate (for further details, see Table 2.6 presented in the results section).

The variable of VC stock represents a stock of entrepreneurial experience and funds of venture capitalists at the beginning of the year. Therefore, it has been introduced with a one-year lag in the model.

Control variables

A range of control variables is included in all the regressions.

U is intended to capture the business cycle effect: it is equal to 1 minus the unemployment rate. This should be a better proxy than the usually used rate of utilisation of capital, which applies to manufacturing industries only (which account for about 20% of GDP in OECD countries). In the context of this study, it is also better than the output gap, as the OECD calculation of the output gap relies on certain assumptions on *MFP* growth: by using it, we would be faced with simultaneity problems (if *MFP* is the same on both sides of the equation) or inconsistency (if two different *MFP*s are used on the two sides of the equation). The series come from the OECD.

G is a dummy equal to 1 for Germany in 1991, and 0 otherwise; in order to take into account the exogenous shock of the German unification.

ϕ_i are country dummies which allow country-specific framework conditions that might affect long-term growth.

φ_t are time dummies which take into account exogenous technical change and exogenous shocks that are common to several countries.

After having explained all variables, we introduce the model that will be used to test the different expected impacts of VC on the productivity.

2.3.3. The estimated model

In order to evaluate whether and to what extent VC contributes to economic growth, we transform Equation 2.6 into a long-term form of the model expressed in logarithm, except for the dummy for German Unification that is expressed in level, and the employment rate that is expressed in first logarithmic difference:

$$LMFP_{it} = \beta_{svc} LSVC_{it-1} + \beta_{sbrd} LSBRD_{it-1} + \beta_{sprd} LSPRD_{it-2} + \sigma_U \Delta U_{it} + \sigma_G G + \phi_i + \varphi_t + \mu_{it} \quad (2.7)$$

where Δ represents the first logarithmic difference and L the natural logarithm. In this equation, the parameters that are to be estimated are assumed to be constant across countries and over time; they are defined as follows:

β_{svc} The elasticity of *MFP* with respect to VC.

β_{sbrd} The elasticity of *MFP* with respect to domestic business R&D.

β_{sprd} The elasticity of *MFP* with respect to public R&D.

σ_U The elasticity of *MFP* with respect to the business cycle.

σ_G The impact of the German unification on *MFP* in Germany.

The interpretation of these elasticities must take into account the fact that the explained variable is not GDP but *MFP*. This implies that we capture mainly the spillover effects of R&D and VC, not the total effect on output growth (which also includes the direct effect on private return). This especially concerns business R&D and VC. Indeed, part of the private resources devoted to R&D and/or financed by VC (labour and capital) is already reflected in the calculation of *MFP.* They are in fact included in the economy's stock of capital and pool of labour. Hence, if the social returns to R&D and VC are equal to their private returns, and if the private returns to R&D and VC are equal to their output share (and if the assumptions underlying the calculation of *MFP*, notably perfect competition and constant returns to scale at the aggregate level, hold) then the elasticity of *MFP* with respect to business R&D and VC should equal zero. A positive elasticity would therefore signal the existence of spillovers and a risk premium. Positive spillovers exist when the marginal social benefit of production exceeds the marginal private benefit. As knowledge cannot be perfectly appropriated, this means that there are externalities which profit to others enterprises and to others sectors. The risk premium is the excepted reward for holding a risky investment rather than a risk-free one.

The VC does not generate new knowledge with high potentials of externality but rather organisational competences and tacit intern knowledge of the firm. This

strongly limits the possibility of international spillovers or inter-industrial spillovers, contrary to the R&D which circulates more easily.

A further caveat is that the assumptions used for calculating *MFP* may not be completely satisfied: increasing returns to scale and imperfect competition are often associated with R&D (e.g. Romer, 1990). If this is the case, the MFP-index that we explain might be subject to some measurement errors which might be correlated with the right-hand side variables. In their analyses, Guellec and van Pottelsberghe (2004) discuss this issue and in order to mitigate this problem, they rely on instrumental variables. This method controls for potential simultaneity biases, due to the possible influence of the dependent variable on some of the right-hand side variables. They show, using the same panel as the one used in the present analysis (except for the stock of VC) that there are no significant differences between the parameters estimated with this technique, hence underlying the robustness of the estimates. Concerning the possible endogeneity problem of stock of VC, we have also shown using instrumental variables[13], that we can continue to use fixed effects regression rather than 2SLS-method because of the results of the Wu-Hausman Test[14].

The estimates are performed with a longitudinal data set of 16 OECD countries over the period 1990-2001. These 16 countries are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, United Kingdom and United States. The choice of the sample has been dictated by the availability of the data. The period slightly varies across countries according to the availability of information.

[13] Sargan test is a test of validity of instrumental variables. The null hypothesis is that instrumental variables are uncorrelated to residuals. In this case, the P-value is 0.68 so we don't reject the null hypothesis. So the instruments are accepted.

[14] In this case, the statistic of the Wu-Hausman test is equal to: F= 2.1931 and this value is lower than the tabulated value of the 95 percent quantile of a Fisher distribution with (1,115). So, we cannot reject the hypothesis that SVC(-1) is not endogenous.

Table 2.1: Descriptive statistics (%)

Country	Period	Business R&D capital stock	Public R&D capital stock	Multi-Factor Productivity	VC Investment	VC stock δ = 15%	VC stock δ = 30%	VC stock δ = 45%	VC stock δ = 60%	Business R&D Intensity	VC Intensity
		Yearly average growth rates (%)								% Shares	
Australia	1995-1998	5.79	4.23	2.09	-3.65	-36.14	-4.84	-4.90	-4.66	0.81	0.11
Belgium	1990-1997	3.57	3.34	0.78	14.51	8.35	8.36	9.22	10.50	1.51	0.07
Canada	1995-1999	4.93	1.02	1.18	38.14	33.51	38.66	38.42	38.13	1.23	0.22
Denmark	1990-1999	7.18	4.09	1.46	23.51	12.82	15.10	17.24	19.16	1.75	0.03
Finland	1990-2000	8.33	4.17	3.22	28.31	30.81	30.29	29.80	29.32	2.40	0.09
France	1990-2001	2.67	1.80	0.88	6.91	7.54	9.25	10.03	10.04	1.89	0.09
Germany	1990-1999	1.52	2.35	-0.46	20.52	22.62	21.85	21.46	21.20	2.09	0.06
Ireland	1990-2000	14.37	5.47	3.62	19.87	14.73	16.50	17.74	18.62	1.28	0.10
Italy	1990-2000	2.35	2.07	0.75	23.36	9.76	12.84	15.59	17.99	0.86	0.05
Japan	1994-1998	3.55	3.72	0.11	8.46	2.25	13.55	13.34	12.39	2.26	0.03
Netherlands	1990-2000	2.26	3.18	0.85	23.27	20.08	21.15	21.94	22.51	1.50	0.20
Norway	1990-1999	3.31	3.90	1.63	13.54	29.66	25.07	21.52	18.71	1.48	0.09
Spain	1990-1999	4.16	1.21	0.69	26.23	13.57	16.02	18.33	20.54	0.70	0.04
Sweden	1990-2000	6.33	1.96	1.69	27.15	19.84	22.25	23.94	25.20	4.18	0.09
United	1990-2000	0.97	1.65	0.91	19.82	5.84	9.66	12.67	15.04	1.79	0.15
United States	1990-1999	2.96	1.56	1.24	30.85	13.26	16.83	20.11	23.11	2.22	0.16

Sources: OECD, MSTI, EVCA and own calculations

Country-specific descriptive statistics of all variables for the 1990-2001 period (or the longest available period) are presented in Table 2.1. The *MFP* growth ranges from -0.46 % a year in Germany to 3.62 % in Ireland. This weak rate for Germany is mainly due to the unification process. Most countries, however, are very close to 1 % a year. The *MFP* growth is high for Ireland, as this country has been catching up over the period. Business R&D (capital stock) growth ranges from 0.97 % (United Kingdom) to 8.33 % (Finland) and to an outstanding performance of 14.37 % for Ireland. Most countries are between 3.5 % and 7 %.

The growth of publicly performed R&D was much lower than that of business R&D over the same time period. It ranges from 1.02 % (Canada) to 5.47 % (Ireland), with most countries reporting between 3 % and 5 %. The two major reasons for this lower growth rate of public R&D seem to be on one hand the end of the cold war, and therefore the reduction of government defence spending, and on the other hand the strained budgetary conditions characterizing many countries' economies.

VC investment is much more volatile, ranging from -3.65 % in Australia to 38.14 % in Canada with the United States and Finland above 28 %. Note that we only have data from 1995 to 1999 for Canada and from 1995 to 1998 for Australia, which can explain these high values. The descriptive statistics for the VC stock with 15, 30, 45 and 60 per cent of depreciation rate show that despite a higher volatility, the average growth rates of VC investment and VC stock have been much higher than the growth rate of business R&D capital stock, except for a few countries.

The R&D intensity (R&D investment divided by the domestic product of industry) varies between 1.2 % and 2.1 % for 9 countries. Sweden, Japan, Finland, and the USA are the best performers in terms of relative effort in R&D. Regarding the VC intensity (VC investment divided by the domestic product of industry) the best performers are not necessarily the countries that have a high R&D intensity or high MFP growth rates. Japan is the least intensive in VC. Australia, Ireland, the Netherlands, the United-Kingdom and the United States are above 0.11 % and Canada is at the top with 0.22 %. In other words, some countries with relatively low effort in research turn out to be very active in terms of VC.

The correlations between the average annual growth rates of each variable are reported in Table 2.2. The *MFP* is quite highly correlated with the business R&D capital stock, witnessing a positive long-term relationship. This long-term impact of

R&D on growth could be expected from the evidence available in the existing literature. The *MFP* is also positively correlated, though to a lower extent than business R&D, with public R&D. With regard to the VC stock, there is no apparent relationship with *MFP*, or with public or business R&D.

Table 2.2: Correlation matrix between average annual growth rates for 16 OECD countries, 1990-2001

	Public R&D capital stock	**Multi-Factor Productivity**	**VC Investment**	**VC stock δ = 15%**	**VC stock δ = 30%**	**VC stock δ = 45%**	**VC stock δ = 60%**
Business R&D capital stock	0.643*	0.848*	0.085	0.043	0.120	0.117	0.111
Venture capital stock δ = 60%	-0.342	0.081	0.932*	0.894*	0.946*	0.987*	
Venture capital stock δ = 45%	-0.277	0.092	0.866*	0.916*	0.985*		
Venture capital stock δ = 30%	-0.196	0.105	0.775*	0.916*			
Venture capital stock δ = 15%	-0.204	0.027	0.758*				
VC Investment	-0.438	0.060					
Multi-Factor Productivity	0.585*						

Sources: Table 2.1; * indicates the significance of the correlation at the 5% probability threshold.

As we have seen in the literature review, there are a number of papers focussing on the causality issues. Indeed, VC seems to encourage innovation and, in turn, the marketing of innovation is likely to spur a larger demand for VC. A major concern of Kortum and Lerner (2000) and Ueda and Hirukawa (2003) is to understand whether VC spurs innovation or rather whether venture investment responds opportunely to the perception that innovations are occurring (or are likely to occur) in a given area. In particular, these authors use instrumental variables that are correlated with the level of VC activity, and that are orthogonal to the level of innovation in a given culture, in order to correct the reverse causality issue.

The objective of this study is not to provide evidence on the causality issue between VC and economic performance but to perform an evaluation of the macroeconomic impact of VC. In order to avoid the potential effect of causality, we have used a one-year-lagged stock of VC (as opposed to VC yearly flows). In addition, Table 2.2 shows

that there is little evidence of cross-country correlation between MFP growth and the VC stocks: the countries with the highest MFP growth rates are not those with the highest VC stocks. So, in this chapter, and as we have seen before, we can assume that the stock of VC is exogenous. This corroborates the results of the test carried out previously. More specifically OLS estimation is preferred to 2SLS given the higher efficiency (and the small bias).

After the description of the model and the data, let us present the results of the estimates.

2.4. Results

Based on the Equation 2.7 in log-levels, our aim is to identify simple, long-term static relationships between *MFP* and its determinants. We can assume that there is a country-specific effect on productivity. This effect must be caught by different fixed constants. Therefore we would like to carry out a fixed effect estimation but another candidate could be to use random effect estimation. Then, the Hausman test is used to choose between these two models. The Hausman statistic of test is equal to 305.16. That is higher than the tabulated quantile value of χ^2_{15} (which is equal to 25). So, we reject the null hypothesis of independence between the random effects and the error terms and then we eliminate the possibility to use random effect estimation. After this, we have used the Show test to know if we have to follow the hypothesis of a constant country effect. The statistic of the Show test is equal to 817.88 that is also higher than the tabulated quantile value of χ^2_{15}. Then we will use fixed effect regressions[15]. The GLS specification allows us to correct for a possible heteroscedasticity problem but not to correct for temporal correlation in the covariance matrix of the errors inside a country. For this problem, we use a feasible GLS specification correcting for both cross-section heteroscedasticity and contemporaneous correlation. Sometimes the Parks estimator is used for this problem

[15] The Breusch-Pagan test was also used. The statistic of test is equal to 8.11 that is also higher than the tabulated quantile value χ^2_1 equal to 3.84 and then we reject the null hypothesis of null variances between countries.

but as Beck and Katz (1995) have shown, this estimator underestimates the standard error. Therefore, we use their estimator. (see Table A.2.2. in Appendix 9.1, page 175).

As far as the direct impact of VC on MFP is concerned, we start by estimating separately the effect of each variable. The results are reported in Table 2.3. All variables have the expected signs and are highly significant.

Table 2.3: Multifactor productivity estimation results in log-levels

Dependent variable: Log MFP					
Regressions		**1**	**2**	**3**	**4**
Log Venture capital stock (t-1) $\delta = 30\%$	*LSVC*	0.014***			
		(4.88)			
Log Business R&D capital stock (t-1)	*LSBRD*		0.213***		0.195***
			(15.31)		(12.09)
Log Public R&D capital stock (t-2)	*LSPRD*			0.392***	0.161***
				(9.29)	(3.66)
Control variables					
Employment rate growth (t)		0.809***	0.435***	1.021***	0.651***
		(4.42)	(2.72)	(5.76)	(3.85)
German reunification dummy (t)		-0.0002	-0.017	-0.001	-0.015
		(-0.003)	(-0.55)	(-0.02)	(-0.43)
Country-specific intercept		Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes
Adjusted R-squared		0.941	0.976	0.990	0.986

Note: Panel data, 16 OECD countries, 1990-2001, 148 observations. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. The econometric method is GLS. T-Statistics in parentheses.

The econometric results with the progressive introduction of each variable are reported in Table 2.4. The variables of business R&D capital stock that represents stock of knowledge, and VC stock that represents entrepreneurial experience and funds of venture capitalists, have been introduced with a one-year lag (or the stock at the beginning of the year), and two-years lag for the public R&D capital stock. R&D performed by universities largely concerns basic research and, as it takes time until basic R&D affects industrial productivity, a longer time lag is justified.

The results for different specifications are reported, in order to test the stability of our estimates. The control variable 'business cycle', as proxied by the growth of employment rate, is associated with an expectedly large and positive parameter. This confirms previous findings that the measure of productivity is substantially affected by the capacity utilization rate.

The progressive introduction of other sources of knowledge significantly improves the overall fit of the model. The estimates suggest that the accumulation of VC significantly contributes to total factor productivity growth. The estimated parameters remain stable (columns 5 and 6) after the withdrawal of the control variables and/or time dummies, witnessing the robustness of the estimated parameters.

The most appropriate estimates are displayed in column 3. These results include the three sources of knowledge, the two control variables, and country and time dummies. The elasticities of output with respect to the stocks of VC, business R&D and public R&D are 0.9 %, 19.9 %, and 13.6 %, respectively. In other words, the output elasticity of business R&D is higher than the output elasticity of public R&D and nearly 20 times as high as the output elasticity of VC. This result is probably due to a high risk-premium and by the large potential spillovers or knowledge externalities associated to VC.

As the direct impact of R&D and VC on output is at least partly accounted for by the *MFP*, the positive parameters must mainly capture spillovers and possibly a premium (coming in addition to normal remuneration of capital and labour) arising from R&D and VC. In addition, these estimates are elasticities: relative increase in output due to a relative increase in the stock of knowledge. For instance, a 1 % variation in the business R&D capital stock would yield a 0.2 % variation in output. In order to quantify these estimates in monetary terms (€), one must compute the marginal impacts of these sources of knowledge.

Table 2.4: Multifactor productivity estimation results in log-levels

		Dependent variable: Log MFP					
Regressions (GLS)		**1**	**2**	**3**	**4**	**5**	**6**
Log Venture capital stock (t-1) δ = *30%*	*LSVC*	0.014***	0.012***	0.009***	0.047***	0.006***	0.007**
		(4.88)	*(4.17)*	*(2.92)*	*(9.59)*	*(2.53)*	*(2.40)*
Log Business R&D capital stock (t-1)	*LSBRD*		0.214***	0.199***		0.197***	0.214***
			(14.98)	*(12.18)*		*(12.91)*	*(15.83)*
Log Public R&D capital stock (t-2)	*LSPRD*			0.136***		0.135***	0.142***
				(2.92)		*(5.52)*	*(5.67)*
Control variables							
Employment rate growth (t)		0.809***	0.519***	0.629***	1.60***	0.828***	
		(4.42)	*(3.07)*	*(3.57)*	*(7.89)*	*(6.62)*	
German reunification dummy (t)		-0.0002	-0.014	-0.012	-0.036	-0.017	
		(-0.003)	*(-0.40)*	*(-0.34)*	*(-0.87)*	*(-0.45)*	
Country-specific intercept		Yes	Yes	Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	No	No	No
Adjusted R-squared		0.941	0.953	0.971	0.753	0.989	0.974

Note: Panel data, 16 OECD countries, 1990-2001, 148 observations. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. The econometric method is GLS. T-Statistics in parentheses.

Table 2.5 shows the marginal impacts, or social rates of return, of the three types of knowledge stocks. They correspond to the elasticities presented in column 3 of Table 2.4. The rates of return are calculated as the elasticities divided by the average intensity of the knowledge stock[16]. For instance, the marginal impact of business R&D is 0.199/(0.0998) = 1.99. The marginal impacts of public R&D and VC are respectively 2.69 and 3.33. In other words, an increase of 1 € in the business R&D capital stock would yield an increase of 1.99 € in output growth. The rate of return to public R&D is slightly higher. What is striking is the social rate of return to VC, which is significantly higher than the social rate of return to business R&D. This is probably due to the high risk-premium of VC and its induced spillover effects on the economy. Indeed, by definition, venture capitalists invest in highly risky projects such as the introduction of highly innovative products and processes on the market. In large firms, development activities also concern more incremental innovations (product and process improvement) that yield lower returns than a successful introduction of a breakthrough innovation.

Table 2.5: Long-term elasticity and rate of return of multifactor productivity

		LT Elasticity	Intensity	Rate of return
Venture capital stock	**δ = 30%**	0.009	0.0027	3.33
Business R&D capital stock		0.199	0.0998	1.99
Public R&D capital stock		0.136	0.0505	2.69

Sources: own calculations, with the parameters presented in Table 2.4, column 3.

Analyses on balanced sample are reported in Table A.2.2. (Appendix 9.1., page 175). The results of these regressions are not significantly different. The inclusion of the four countries with the smallest temporal coverage (Australia, Belgium, Canada and Japan) does not change a lot the significance and the sign of the coefficients obtained with the largest sample.

[16] Since there is heterogeneity in the amounts of VC investments, we choose to compute constant elasticities. The rates of return are computed ex-post in this chapter.

Table 2.6 shows the results of sensitivity analyses. The tests are made for VC depreciation rates of respectively 15, 30, 45 and 60 per cent. Here also, the results of the regressions do not change significantly depending on the chosen sample and the chosen depreciation rate of VC.

The second potential effect of VC on economic performances is an indirect one. Since VC activities can be compared to an intensive learning process, it is assumed that it would improve and speed up the absorptive capacity of firms. The potential mechanism is similar to the one emphasized by Griffith *et al.* (2003) and Guellec and van Pottelsberghe (2001 and 2004) with R&D outlays. These authors show that the countries with a higher R&D intensity have a higher impact of their business R&D capital stock, thanks to an improved absorptive capacity of existing knowledge (inside and outside the firm's boundaries).

In order to test the hypothesis of an absorptive capacity associated with both R&D investment and VC, we estimate a model similar to Equation 2.7, but where VC intensity and business R&D intensity (i.e. the ratio of business R&D expenses on DPI, the Domestic Product of Industry) interact with the various knowledge capital stocks (Equation 2.8). The results are presented in Table 2.7.

$$LMFP_{it} = \beta_{sbrd}\ LSBRD_{it-1} + \beta_{sbrd'}(LSBRD_{it-1} * RDI_{it}) + \beta_{sbrd''}(LSBRD_{it-1} * VCI_{it}) + \beta_{sprd}\ LSPRD_{it-2} + \beta_{sprd'}(LSPRD_{it-2} * RDI_{it}) + \beta_{sprd''}(LSPRD_{it-2} * VCI_{it}) + \sigma_U\ \Delta U_{it} + \sigma_G\ G + \phi_i + \varphi_t + \mu_{it} \quad (2.8)$$

A country's business R&D intensity has a positive effect on the elasticity of the business R&D capital stock as shown in column 1 of Table 2.7. This finding confirms to some extent the existence of increasing returns to investment in research activities. Increasing returns to scale is the basic assumption of the theory of endogenous technical change (see Romer, 1990). By spending more on R&D, firms are able to reap internal economies of scale, to set up networks, and to benefit from each other's discoveries. It also denotes an improved ability to absorb the knowledge generated by other firms and/or industries. The intensity of VC funding has also a positive effect on the elasticity of the business R&D capital stock (column 2). When we simultaneously introduce the product of the business R&D capital stock with the R&D intensity and the VC intensity (column 3), we observe that the positive impact of business research is much higher in countries were the R&D intensity and the VC intensity is higher.

Table 2.6: Multifactor productivity estimation results in log-levels (with different depreciation rates of VC stock)

		Dependent variable Log MFP							
		δ = 15%		**δ = 30%**		**δ = 45%**		**δ = 60%**	
Regressions		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Log Venture capital stock (t-1)	*LSVC*	0.011***	0.006**	0.014***	0.009***	0.013***	0.008***	0.013***	0.008***
		(4.66)	*(2.21)*	*(488)*	*(2.92)*	*(4.96)*	*(2.90)*	*(4.84)*	*(2.85)*
Log Business R&D capital stock (t-1)	*LSBRD*		0.200***		0.199***		0.199***		0.198***
			(12.30)		*(12.18)*		*(12.27)*		*(12.39)*
Log Public R&D capital stock (t-2)	*LSPRD*		0.128***		0.136***		0.141***		0.145***
			(2.69)		*(2.92)*		*(3.07)*		*(3.19)*
Control variables									
Employment rate growth (t)		0.831***	0.595***	0.809***	0.629***	0.827***	0.629***	0.839***	0.625***
		(4.41)	*(3.36)*	*(4.42)*	*(3.57)*	*(4.45)*	*(3.59)*	*(4.42)*	*(3.58)*
German reunification dummy (t)		0.001	-0.013	-0.0002	-0.012	-0.001	-0.013	-0.002	-0.014
		(0.01)	*(-0.35)*	*(-0.003)*	*(-0.34)*	*(-0.03)*	*(-0.35)*	*(-0.05)*	*(-0.37)*
Country-specific intercept		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared		0.941	0.963	0.941	0.971	0.943	0.971	0.945	0.971

Note: Panel data, 16 countries, 1990-2001, 148 observations. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. The econometric method is GLS. T-Statistics in parentheses.

Table 2.7: Multifactor productivity estimation results in log-levels: VC and R&D as factors of absorptive capabilities

		Dependent variable: Log MFP					
Regressions		**1**	**2**	**3**	**4**	**5**	**6**
Log Business R&D capital stock (t-1)	*LSBRL*	0.175***	0.204***	0.188***	0.176***	0.204***	0.189***
		(9.75)	*(12.68)*	*(10.28)*	*(9.85)*	*(12.69)*	*(10.36)*
LSBRD (t-1) * R&D intensity		0.093***		0.065**			
		(3.01)		*(1.99)*			
LSBRD (t-1) * VC intensity			0.387***	0.362***			
			(4.02)	(3.44)			
Log Public R&D capital stock (t-2)	*LSPRL*	0.204***	0.168***	0.202***	0.203***	0.166***	0.201***
		(4.54)	*(3.83)*	*(4.63)*	*(4.51)*	*(3.79)*	*(4.59)*
LSPRD (t-2) * R&D intensity					0.098***		0.069**
					(3.06)		*(2.05)*
LSPRD (t-2) * VC intensity						0.401***	0.373***
						(4.00)	*(3.41)*
Control variables							
Employment rate growth (t)		0.554***	0.599***	0.572***	0.554***	0.598***	0.571***
		(3.36)	*(3.82)*	*(3.72)*	*(3.35)*	*(3.81)*	*(3.71)*
German reunification dummy (t)		-0.016	-0.015	-0.015	-0.016	-0.015	-0.015
		(-0.53)	*(-0.44)*	*(-0.49)*	*(-0.53)*	*(-0.44)*	*(-0.49)*
Country-specific intercept		Yes	Yes	Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared		0.970	0.977	0.973	0.970	0.977	0.973

Note: Panel data, 16 countries, 1990-2001, 148 observations. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. The econometric method is GLS. T-Statistics in parentheses.

The elasticity of public research is also higher when the business R&D intensity is higher. This shows the importance of the business sector being able to seize opportunities raised by public research (column 4). Therefore, part of the effect of public research on productivity is indirect, flowing through the use of its discoveries by the business sector research activities. Stronger links between public and private research, which governments in most OECD countries are trying to build, should enhance this effect. The intensity of VC investment also positively affects the impact of public R&D (columns 5 and 6). More VC allows firms to absorb more knowledge from outside the firm's boundaries. Therefore, VC is expected to increase the innovative performance of firms and the aggregate impact of business and public R&D activities.

2.5. Concluding remarks

Our analysis constitutes a first attempt to evaluate the economic impact of VC. The starting point of our investigation is that VC can be considered, in several respects, to be similar to experimental development performed by large firms because the definition of R&D is quite similar to the activities that are performed in small innovative companies. Moreover, the OECD Frascati manual (2002) specifies that R&D is not the only way to introduce new products or processes and that venture capitalists can give important advice to firms. It seems legitimate to assume that VC is a stepping stone for the growth of firms benefiting from it. The econometric results confirm our assumption that VC contributes to growth through two main channels. The first one is the introduction of new products and processes on the market. The second one is the development of an improved absorptive capacity of the knowledge generated by private and public research institutions.

The social return of VC is much larger than the return of business or public R&D, probably due to a high risk-premium and large potential spillovers or knowledge externalities – large firms devote the bulk of their research activities to product or process improvement which is associated with lower risks and lower expected returns. A high VC intensity further allows to improve the economic impact of private and public R&D capital stocks. In other words, VC improves the "crystallisation" of knowledge into new products and processes.

According to our estimates, VC must be considered as an additional "link" explaining variations in economic performances. In the line of Audretsch and Keilbach (2003)'s empirical results, we confirm Baumol's conjecture that entrepreneurial activity may account for a significant part of the "unexplained" residual in the traditional production function. These results therefore call for innovative policy instruments aiming for a stimulation of the participation of the private VC funds available on the market.

CHAPTER 3:

TECHNOLOGICAL OPPORTUNITY, ENTREPRENEURIAL ENVIRONMENT AND VENTURE CAPITAL DEVELOPMENT

3.1. Introduction

The previous chapter has shown the large impact of Venture Capital (VC) on productivity. These conclusions are in line with other empirical studies on the economic impact of VC like Engel (2002), Hellmann and Puri (2002), and Kortum and Lerner (2000). Broadly, the main results are that despite this wide recognition of venture funds as key players underlying economic performances, there are huge differences across industrialized countries with respect to the relative amounts of VC. It is relatively high in the USA and Canada for instance, whereas it is very low in Japan. The diversity of national financial systems is undoubtedly one important factor explaining the observed international differences (Black and Gilson, 1998).

However, several authors have shown that other factors also play an important role. Jeng and Wells (2000) using a panel dataset of 21 countries, show that labour market rigidities, the level of Initial Public Offerings (IPO)[17], government programs for entrepreneurship, as well as bankruptcy procedures explain a significant share of cross country variations in VC intensity. Gompers and Lerner (1998) focus exclusively on the US market and identify several factors influencing the level of VC. Finally,

[17] Initial Public Offering is the first sale of stocks by a private company to the public (stock market).

Shertler (2003) looks at the driving forces of VC activity for 14 Western European countries (i.e. liquidity of stock markets and the availability of human capital approximated by R&D intensity of the countries).

The objective of this chapter is to contribute to this recent stream of research. Our central hypothesis is that two broad factors so far overlooked by the existing empirical literature, might also contribute to explain the heterogeneity of VC intensity across countries. These factors are related to the entrepreneurial environment and to technological opportunity proxied for example, by the number of patents. It is striking that the literature more focused on the financial aspects such as Black and Gilson and Jeng and Wells ignore the fact that venture capitalists overwhelmingly invest in technology ventures.

We first develop a theoretical model which takes into account the factors that affect the demand and supply of VC. They include the growth of GDP, interest rates, several indicators of technological opportunity (the business R&D expenditures growth rate, the level of business R&D capital stock and the number of triadic patents), and indicators of entrepreneurial environment such as the level of taxation, an index of labour market rigidities and an index of entrepreneurial activities. In order to evaluate the parameters of the theoretical model, we exploit a panel dataset composed of 16 countries over an eleven years period (1990-2000).

The results show that GDP growth, technological opportunity and interest rates significantly influence VC intensity. The number of patents stimulates the level of VC intensity. The countries with lower labour market rigidities benefit from a higher impact of the GDP growth rate and the available stock of knowledge on the relative level of VC. Higher levels of entrepreneurship – i.e. the percentage of people being involved in the creation of nascent firms – induce a positive and significant relation between the R&D capital stock and VC intensity.

The chapter is structured as follows: the next section summarizes the main findings of the few existing evaluations of the determinants of VC. A theoretical model of demand and supply of VC and the econometric model are developed in section three. Section four presents the data. The empirical results are interpreted in section five. Section six concludes.

3.2. Literature review

Four main streams of research have identified various determinants of venture capital intensity. The first one focuses mainly on differences in financial systems. For instance, Black and Gilson (1998) provide evidence that an active stock market is crucial for the development of strong venture capital market because of the potential for VC exit through an Initial Public Offering. A second stream of research analyses the historical and socioeconomic context influencing the development of a VC industry (see Feldman (2001), Kenney and von Burg (1999), Kenney (2001), and Avnimelech *et al.* (2005)). The third one is more interested in behavioural analyses at the microeconomic level. Few articles have so far focused on the determinants of VC performance (Hege *et al.* (2003), Manigart *et al.* (2002)). For Gompers and Lerner (1998) the individual firm performance and reputation, measured with the firm age and size, positively affect the capacity to raise larger funds. Hellmann and Puri (2000) show that the product market strategy of a company is one of the determinants of VC investment when controlling the age of the company and its industrial sector. If the strategy is an innovative one[18], it has a higher probability to benefit from VC compared to companies that follow an imitation strategy[19].

In this chapter, the focus is on a fourth stream of research: the macroeconomic determinants of VC. To the best of our knowledge, only a few articles attempted so far to evaluate quantitatively the macroeconomic determinants of VC. Jeng and Wells (2000) develop a model aiming at identifying the determinants of VC and test it on a cross-section of 21 countries over a period of 10 years. Gompers and Lerner (1998) focus on the US economy over the period 1969-1994. Schertler (2003) analyses the driving forces of VC activities for 14 Western European countries between 1988 and 2000. Their results are summarized by type of variables used (e.g. Labour market rigidities, Capital Gains Tax Rate, Level of interest rate…) in Table 3.1.

[18] The company is the first to introduce a new product or service for which no close substitute is yet offered on the market.

[19] The company uses existing technologies to develop and improve products and processes. Imitators and innovators are engaged in relatively new products and technologies, but they are not the first movers in their markets, and therefore tend to compete on aspects other than innovation.

Table 3.1: Potential determinants of VC

	Gompers and Lerner (1998)	**Jeng and Wells (2000)**	**Schertler (2003)**
	US, 1972-1994	**21 countries, 1986-1995**	**14 European countries, 1988-2000**
Initial Public Offering	No effect at aggregated level of the Market Value of IPO	+ Except for early stage funds	n.a.
Gross Domestic Product	+	Not significant	n.a.
Stock Market Opportunities [a]	+	Not significant	Not significant
Finance reporting standards	n.a	-	n.a.
Labour market rigidities	n.a.	Not significant for total VC investment but - for early stage funds	+ on early stage investments
Private pension funds	(Dummy for changes in ERISA's prudent man rule) +	(Level and growth of pension funds) + Over time but not across countries	n.a.
Capital Gains Tax Rate	-	Not significant	n.a.
Level of interest rate	+ At aggregated level and - at state level	n.a.	n.a.
Industrial and academic R&D	(expenditures) +	n.a.	(number of employees) +
Number of Patent	n.a.	n.a.	Too small number of observations

[a.] This variable is proxied by an indicator of equity market return by Gompers and Lerner (positive and significant), by an indicator of market capitalization growth by Jeng and Wells (not significant, but probably correlated with GDP and IPO), and by an indicator of growth rate of stock market capitalisation by Schertler (positive on early stage investments).

The impact of IPOs have been analysed in the literature. Gompers and Lerner take it as a proxy for fund performance but cannot find any significant effect in their empirical estimates. It seems that the IPO variable is strongly correlated with the expected return on alternative investments and with the Gross Domestic Product (GDP), which might also be considered as a proxy for exit opportunities. On the other hand, according to Jeng and Wells, IPOs are the strongest driver of VC because it reflects the potential return to VC funds. GDP and Market Capitalization Growth (MCG) are part of the impact of IPO's and therefore turn out to be not significant for them. However the reverse is true for Gompers and Lerner who find a positive and significant impact of equity market return and GDP on VC but no impact of IPO. Higher GDP growth implies higher attractive opportunities for entrepreneurs, which lead to a higher need for venture funds. Although Schertler finds that the growth rate of the stock market capitalisation does not have a significant impact on VC investments at early stages (this is also demonstrated by Jeng and Wells), she finds that liquidity of stock market has a significant positive impact on VC investments at early stages. She uses either the capitalisation of stock markets or the number of firms listed as a measure of the liquidity of stock markets.

For Jeng and Wells, getting the basic legal and tax structures in place appears to be an important factor influencing VC. Gompers and Lerner also recognize the importance of government decisions on the private equity funds. One of these government decisions is the labour market legislation. This legislation is typically put in place to protect employees from arbitrary, unfair or discriminatory actions by employers. Some authors argue that venture financing can suffer from the rigidity of the labour market in Europe (e.g. Balboa and Marti, 2001). Jeng and Wells show that it does not significantly influence total VC but affects negatively the early stage of VC investment. According to Shertler, the effect of labour market rigidities is positive and significant. We cast doubt on this result since we can expect that incentives for entrepreneurship are higher in economies with flexible labour market. Shertler justifies her result by pointing to the differences in the labour-capital ratio of high-technology enterprises. Indeed, she argues that high-technology enterprises operating in rigid labour markets may demand more capital than comparable high-technology enterprises operating in flexible labour markets.

With the clarification of the Employee Retirement Income Security Act (ERISA) "prudent man" rule of 1979, the share of money invested by pension funds in VC had risen to more than 50 % in the United States. Jeng and Wells find that the level of investment by private pension funds in VC is a significant determinant of VC over time but not across countries. Gompers and Lerner use a proxy for the amendment of the "prudent man" rule to show the impact of pension regulation and reach a similar conclusion. After 1979, the additional capital provided by pension funds led to a dramatic shift in commitments to VC.

Capital Gains Tax Rate (CGTR) on VC activity is often considered as a potential determinant of VC. Gompers and Lerner show that a decrease in CGTR has a positive and important impact on commitment to new VC funds. In fact, they confirm the result of Poterba (1989) who built a model of decision to become an entrepreneur. Poterba found that decreases in CGTR might encourage the raising of VC funds not through stimulation of the supply side (i.e. the potential fund providers) but rather on the demand side. Indeed, decreases in CGTR often encourage entrepreneurship and, thus, the desire of people to create their own firm and to engage in R&D activities. Anand (1996) also highlights the fact that the level and composition of investments appear to be negatively affected by increases in the CGTR but investments in one industry may be affected by a myriad of other factors like technology shifts, tastes, etc.

Interest rates seem also to be an important factor influencing VC. However, only Gompers and Lerner introduce this factor in their analysis. They show that it positively affects the demand for VC funds in the United States. Indeed, from the entrepreneur's point of view, if interest rates increase, debt financing becomes more costly implying an increase of the use of an alternative source of fund like VC.

Both industrial and academic R&D expenditures are significantly related to venture capital activity at the State level in the model of Gompers and Lerner. For them, the growth of VC fundraising in the mid-1990s may be due to increases in technological opportunities. Shertler tests the number of employees in research and development and the number of patents as instrument variables for human capital endowment. She finds a positive impact of the number of R&D employees. Also, she highlights that the coefficients of the patent variable are positive and highly significant. However, this result could be biased due to the low number of observations because patent data are

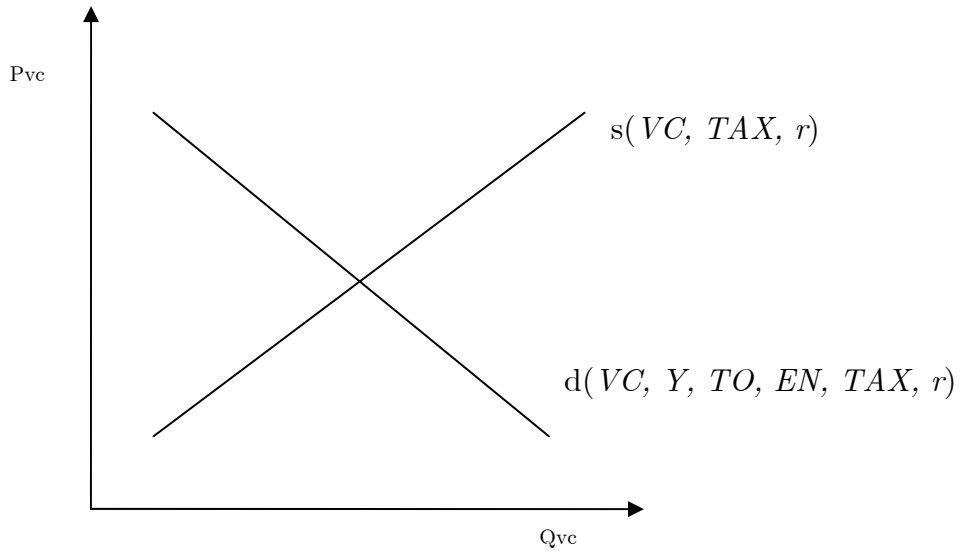
not available for 1999 and 2000. Neither Gompers and Lerner nor Jeng and Wells test the impact of intellectual property rights on the level of VC funds.

3.3. Modelling the amount of venture capital

As Poterba (1989) and Gompers and Lerner (1998), we argue that changes in the level of VC funds come from changes either in the supply or the demand of VC. The demand comes from the entrepreneurs willing to set up an innovative start-up. The supply of VC corresponds to the share of risk capital provided by private investors, pension funds and banks. The actual amount of VC invested represents the equilibrium between the demand and the supply of VC.

The supply and demand of VC can be modelled through Equation (3.1) and Equation (3.2), respectively. They characterize the supply price of VC, P^s, and the demand price of VC, P^d. We can assume that the VC quantity is linked to the two prices that represent the risky interest rate (Figure 3.1).

Figure 3.1: Demand and Supply of VC



The supply price of VC is assumed to be a positive function of the available VC funds (VC), the interest rate (r) and the corporate tax rate (TAX).

$$P^{S}_{VC} \approx a_C + a_{vc}\ VC + a_{tax}\ TAX + a_r\ r \qquad (3.1)$$

The rationale for the various explanatory variables of the supply price of VC are the following:

Rationale 1: The more VC is available on the market, the higher will be the supply price of VC. This comes from the increasing marginal costs ($a_{vc}>0$), which is due to the fact that the more venture capitalists invest, the higher their risk.

Rationale 2: Interest rates are likely to affect the amount of capital that venture capitalists can expect to receive from investors in order to make investments. If interest rates increase, the VC fund providers will increase their return requirement[20] implying that the VC supply price will increase as well ($a_r>0$).

Rationale 3: The tax rate is integrated in the model as it could influence the price of VC. The objective is to determine whether an increase in the corporate income tax rate would increase the return requirements ($a_{tax}>0$).

The equation of the demand price of VC reflects the entrepreneurs' point of view. The factors that are assumed to influence the demand of VC are the available VC funds (VC), the GDP growth (Y), technological opportunities (TO), entrepreneurial culture (EN), the level of corporate income tax rate (TAX) and interest rates (r).

$$P^{d}_{VC} \approx b_C + b_{vc}\ VC + b_Y\ Y + b_{to}\ TO + b_{en}\ EN + b_{tax}\ TAX + b_r\ r \qquad (3.2)$$

The rationale for the various explanatory variables of the demand price of VC are the following:

Rationale 4: Decreasing marginal returns to VC is assumed, indicating that the projects with the largest excess returns are selected first. The more VC is available, the lower the demand price of VC ($b_{vc}<0$).

Rationale 5: Countries with a high GDP growth, large technological opportunities and a strong entrepreneurial culture are more likely to be associated with a strong demand for VC (and hence positive effects on the demand price of VC: $b_Y>0$, $b_{to}>0$ and $b_{en}>0$). Indeed, high GDP growth is representative of a good conjuncture, which

[20] otherwise they would opt for alternative investments opportunities

induces dynamism leading to companies' creation. Moreover, technological opportunities spur the innovation and the creation of start-ups to develop and commercialize new processes and products. This mechanism raises the demand of VC and thus the VC price. Finally, a real entrepreneurial culture in a country stimulates the creation in all sectors and hence, the number of high-tech start-ups also grows. This will generate a higher demand for risky investments by funds providers like venture capitalists.

Rationale 6: Similarly as for the supply, the level of taxation might have a negative impact on the demand for VC. Indeed, a high level of taxation reduces the rate of entrepreneurship and thus the demand for VC (therefore $b_{tax}<0$).

Rationale 7: Innovative start-ups need important amounts of money. Interest rates are included as an indicator of alternative offer of funds. Indeed entrepreneurs could ask banks for additional funds if interest rates go below the implicit costs (return requirement and loss of control) linked to VC. Conversely, if the interest rate increases entrepreneurs are more likely to switch from the banking sector to the venture fund providers[21], which will be able to increase their price. Hence we assume a positive effect of the interest rate on the demand price of VC ($b_r>0$).

Equations (3.3) and (3.4) show the equilibrium level of VC that equalizes the supply and demand of VC.

$$(a_{vc} - b_{vc})\, VC \approx (b_C - a_C) + b_{\hat{Y}}\, Y + b_{to}\, TO + b_{en}\, EN + (b_{tax} - a_{tax})\, TAX_{it} + (b_r - a_r)\, r \qquad (3.3)$$

$$\text{where} \begin{cases} a_{vc} > 0 \rightarrow & \text{increasing marginal cost of VC Investment} \\ b_{vc} < 0 \rightarrow & \text{decreasing marginal return} \\ (a_{vc} - b_{vc}) \rightarrow & \text{always positive} \end{cases}$$

[21] Although, the literature seems to show that bank financing could be an inappropriate funding source for start-ups, a survey on Technology-Based Small Firms (TBSF) in Belgium seems to indicate that banks is the first money provider of external funds even for TBSF (see chapter 5: TBSF – statistical evidences).

$$VC \approx \left[\frac{(b_C - a_C)}{(a_{vc} - b_{vc})}\right] + \left[\frac{b_{\hat{Y}}}{(a_{vc} - b_{vc})}\right] Y + \left[\frac{b_{to}}{(a_{vc} - b_{vc})}\right] TO + \left[\frac{b_{en}}{(a_{vc} - b_{vc})}\right] EN + \left[\frac{(b_{tax} - a_{tax})}{(a_{vc} - b_{vc})}\right] TAX + \left[\frac{(b_r - a_r)}{(a_{vc} - b_{vc})}\right] r \quad (3.4)$$

Since the denominator is always positive, the numerator provides the expected sign of the parameters between brackets. All the right-hand side variables, except the level of taxation and the interest rate, are expected to have a positive impact on VC. Concerning interest rate (r), the impact can be either positive or negative depending on the difference between the demand price effect and the supply price effect. If the demand price effect of a high interest rate is larger than its supply price effect, the overall impact of interest rates on VC should be positive. The effect of the level of corporate income tax rate on the equilibrium level of VC will always be negative since $(b_{tax} - a_{tax})$ is always negative.

The empirical implementation of Equation (3.4) is presented in Equations (3.5) and (3.6).

Model with no interaction

$$VC_{it} = \beta_{\Delta gdp}\, \Delta GDP_{it} + \beta_r\, r_{it} + \beta_{\Delta brd}\, \Delta BRD_{it-1} + \beta_{sbrd}\, SBRD_{it-1} + \beta_{pat}\, LPAT_{it-2} + \beta_{citr}\, CITR_{it} + \sigma_G\, G + \phi_i + \varphi_t + \mu_{it} \quad (3.5)$$

Model with interactions with TEA and RIG

$$VC_{it} = \beta_{\Delta gdp}\, \Delta GDP_{it} + \beta_r\, r_{it} + \beta_{sbrd}\, SBRD_{it-1} + \beta_{citr}\, CITR_{it} + \beta_{rig}\, (\Delta GDP_{it} * RIG_i) + \beta_{tea}\, (SBRD_{it-1} * TEA_i) + \sigma_G\, G + \phi_i + \varphi_t + \mu_{it} \quad (3.6)$$

where Δ represents the first logarithmic difference, L the natural logarithm, β_X is the parameter related to variable X, GDP is the growth domestic product, r is the interest rate, BRD is the business R&D expenditures, SBRD is the business R&D capital stock, CITR is the corporate income tax rate, PAT is the number of triadic patents RIG is the labour market rigidities, TEA is the level of entrepreneurship, $\boldsymbol{G}$ is a dummy for Germany in 1991, $\boldsymbol{\phi_i}$ are country dummies, $\boldsymbol{\varphi_t}$ are time dummies and μ_{it} is the error term.

Technological opportunity is proxied by three variables: the growth rate of business R&D outlays, the business R&D capital stock and the number of triadic patents. The growth rate of business R&D expenditures represents the research dynamics of a country. The business R&D capital stock is an indicator of the available stock of knowledge (or of the cumulated innovative efforts). The number of triadic patents is an indicator of innovative output. It measures the number of highly valuable inventions developed in each country (it is counted by country of inventor and by priority year).

The entrepreneurial environment can be measured with three variables: the level of taxation, the level of entrepreneurial activity and labour market rigidities. Other factors, like shareholder rights, legal protection, accounting standards could also be taken into account to measure the entrepreneurial environment. The level of taxation is measured with the corporate income tax rate ($CITR$). If entrepreneurs are successful, the key tax will be levied on capital gains, but unfortunately collecting comparable capital gains tax rates for our sample of 16 OECD countries was not possible, as for instance, in the United States, the capital gains tax rate differs between states. Nevertheless, in order to test the impact of tax rate, we rely on corporate income tax rate as proxy in the model. The measures of entrepreneurial activity (TEA) and labour market rigidity (RIG) are indices that are available for one year in our database. Entrepreneurial activity (TEA) is expected to improve the entrepreneurial culture (EN) while labour market rigidity (RIG) diminishes it. We therefore introduce them in interaction with other variables. For instance, we test whether RIG would affect the impact of GDP growth rate on the intensity of VC. This is equivalent to test whether the impact of GDP growth rate on VC intensity is composed of a fixed component ($\beta^{c}_{\Delta\ gdp}$) and a component that varies across countries according to the level of labour market rigidities (i.e. $\beta_{\Delta\ gdp} = \beta^{c}_{\Delta\ gdp} + \beta_{rig}\,\Delta GDP$). Similarly, labour market rigidity (RIG) and the level of entrepreneurship (TEA) might affect the impact of the available stock of knowledge, $SBRD$, on VC. These interactions are illustrated in Equation (3.6).

The parameters to be estimated with the two equations are assumed to be constant across countries and over time. The following table (Table 3.2) presents the various parameters with their interpretation and expected sign.

Table 3.2: Expected sign of the parameters

Parameter	Interpretation	Expected sign
$\beta_{\Delta\ gdp}$	The impact of GDP growth	+
β_r	The impact of interest rate	?
$\beta_{\Delta\ brd}$	The impact of business R&D expenditures growth rate	+
β_{sbrd}	The impact of the level of business R&D capital stock	+
β_{pat}	The impact of the number of triadic patents	+
β_{rig}	The impact of labour market rigidities on $\beta_{\Delta\ gdp}$	-
β_{rig}	The impact of labour market rigidities on β_{sbrd}	-
β_{tea}	The impact of the level of entrepreneurship on β_{sbrd}	+
β_{citr}	The impact of the $CITR$	-

3.4. The variables

A. Venture capital intensity

VC is the venture capital intensity[22]. It has been computed using domestic venture capital investment by country[23] in constant 1990 GDP prices and US PPPs divided by GDP in constant 1990 GDP prices and US PPPs. The series come from the EVCA and the OECD.

[22] It must be noted that the venture capital variable used in this chapter (VC intensity) is different from the one used in chapter 2 (stock of VC with a one-year lag). The endogeneity problem between the two VC variables is limited. Indeed, the stocks of previous years influence the current quantity of VC which influences itself the VC flow. On the contrary, the current VC flow does not influence the stocks of previous years.

[23] VC investments also exist per stage of development and per source of finance but they are only available for a limited number of countries. In this work, we have privileged the geographic coverage. For study per stage of development, see Rosen (2004).

As explained in the previous chapter, it is extremely difficult to use aggregated data on VC activities because of the limited availability and reliability. Definitions and data collection about VC are different in the USA and in Europe. The European Venture Capital Association definition of the VC included management buy-outs (MBOs) and management buy-ins (MBIs)[24]. Therefore, although we know that private equity finance in buy-outs may also be associated with innovative activity (EVCA, 2001a), in the present analysis, and in order to have homogenous definition of VC, venture expenditures include only seed, start-up and early stage capital and do not include replacement capital and buyout.

B. Macroeconomic conditions

Macroeconomic conditions are represented by the economic cycle and the level of interest rates.

Economic cycle

GDP is the gross domestic product. The series come from the OECD Main Science and Technology Indicators.

Interest rates

r is the one-year national deposit interest rate coming from the IMF.

The long-term interest rates (10 years interest rates coming from the OECD) have also been tested. The results lead to similar conclusions. In this study only the results including short-term interest rates are presented.

C. Technological opportunity

Technological opportunity is proxied by three variables: the growth rate of business R&D outlays, the business R&D capital stock and the number of triadic patents.

[24] Definitions of management buy-out (MBO) and management buy-in (MBI) are presented in chapter 2.

Business R&D expenditures and capital stock

BRD is the business R&D expenditures. The series come from the OECD, Main Science and Technology Indicators.

SBRD is the domestic business R&D capital stock. As in chapter 2, the R&D capital stocks have been computed using the perpetual inventory method from total business R&D expenditures, in constant 1990 GDP prices and US PPPs[25].

Business R&D capital stock is used as the proxy of knowledge capital at the beginning of the period. Therefore, Business R&D capital stock has a one-year lag in the model. Business R&D expenditures is also introduced with a one-year lag in the model since it takes time between the invention of a product or service and the creation of a start-up to commercialise it. Several tests with other time lags have been carried out but only the one-year lag has a significant impact on VC intensity.

Patent

PAT is the number of Triadic patents. These patents are named 'Triadic' because they have been applied at the US Patent & Trademark Office (USPTO), the Japanese Patent Office (JPO) and the European Patent Office (EPO). We can therefore assume that they reflect patents with a very high value. The series come from the OECD, Main Science and Technology Indicators. The number of Triadic patents is also introduced with a two-year lag in the model because it takes time for an innovative product (linked to a patent) to be commercialized.[26]

Shertler (2003) takes the number of patents to approximate the human capital endowments. In this chapter, patents are considered more as technological opportunities than as human capital endowments.

[25] For a complete description of the computation refer to the development presented in chapter 2 (page 20).

[26] The use of a two-year lag is supported by other papers like Ernst (2001).

D. Entrepreneurial environment

The entrepreneurial environment can be measured with three variables: the level of taxation, the level of entrepreneurial activity and labour market rigidities

Labour market rigidities

RIG is the employment protection index drawn up by the OECD (1994a) and based on the strength of the legal framework governing hiring and firing of employees. It is a measure of labour market rigidities. The countries are ranked from 1 to 20 with 20 being the most strictly regulated. Since the indicator is fixed over time, it is introduced in interaction with GDP and SBRD.

Entrepreneurial culture

TEA is the Total Entrepreneurship Activity (TEA)-index computed by adding the proportion of adults involved in the creation of nascent firms and the proportion involved in new firms. The series come from the Global Entrepreneurship Monitor (Reynolds *et al.*, 2001). The variable is a ranking from 1 to 20. This measure of entrepreneurial activity can be meaningfully used for international comparisons. We use it as a proxy variable for the entrepreneurial culture. Since the indicator is fixed over time, it is introduced in interaction with another variable of the panel. We chose to make TEA interact with SBRD because we assume that entrepreneurial culture will spur the available knowledge of a country and, as a result, the level of VC intensity.

We have to be careful using the Global Entrepreneurship Monitor (GEM) data. Indeed, although TEA is a good benchmark between countries, we have to keep in mind that GEM database has some weaknesses. First, the GEM study fails to differentiate high-technology start-ups from other medium-low technology companies. Second, this survey is conducted by using computer assisted telephone, interviewing a random sample of people. We can wonder whether this sample is indeed representative of the entire population of the country analysed. However, there is no alternative source for similar data and we decide to include this variable in our specification.

Tax

CITR is the corporate income tax rate. The series come from the Office of Tax Policy Research (OTPR).

E. Control variables

The following control variables are included in all the regressions.

$\boldsymbol{G}$ is a dummy equal to 1 for Germany in 1991, and 0 otherwise; in order to take into account the exogenous shock of the German unification.

$\boldsymbol{\phi_i}$ are country dummies which take into account country-specific framework conditions that might affect VC intensity.

$\boldsymbol{\varphi_t}$ are time dummies which take into account exogenous shocks that are common to several countries.

The estimates are performed with a panel data set of 16 OECD countries over the period 1990-2000. The 16 countries are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, Norway, Spain, Sweden, United Kingdom and United States. The period can vary across countries based on availability of information.

Descriptive statistics of all the variables are presented in Table 3.3[27]. Annual GDP growth ranges from 0.94% in Japan to 7.42% in Ireland. In most countries, however, it varies between 1.68% and 3.11%. The yearly average growth rates of short-term interest rates are always negative as they have diminished in each country during the period.

Concerning technological opportunity indicators, Germany, Italy and United-Kingdom have a very low value of R&D investment growth rate. This rate is even negative in Australia. These weak rates can be partly explained by the short period analysed in our sample. Moreover, in Germany, the important changes triggered by the reunification in 1991 also explain the modest rate. Business R&D (capital stock) growth ranges from 0.97% (United Kingdom) to 8.33% (Finland) and even 14.37% for Ireland.

[27] As the period analysed by country is different, the average over the countries was not computed in the table.

Table 3.3: Descriptive statistics (%)

Country	Period	GDP	Business R&D invest.	Business R&D capital stock	Number of Patents*	Interest rate	Corporate Income Tax Rate	Level of entrepre-neurship	Labour market rigidities	VC Intensity (GDP)
		Yearly average growth rates (%)					Average			Shares
Australia	1995-1998	3.47	-4.64	5.79	6.87	-13.95	0.35	15.2	4	0.09
Belgium	1990-1998	1.68	5.28	3.72	6.77	-8.51	0.39	4.5	17	0.06
Canada	1995-1999	3.49	3.83	4.93	10.47	-8.97	0.38	12.2	3	0.18
Denmark	1990-1999	2.25	6.95	7.18	7.11	-12.31	0.36	7.6	5	0.02
Finland	1990-2000	2.44	9.84	8.33	12.36	-14.16	0.26	12.5	10	0.06
France	1990-2000	1.88	1.37	2.70	0.89	-5.23	0.34	5.0	14	0.07
Germany	1990-1999	2.87	0.59	1.52	4.23	-11.19	0.41	6.9	15	0.05
Ireland	1990-2000	7.42	14.21	14.37	5.99	-33.91	0.37	9.1	12	0.08
Italy	1990-2000	1.74	0.62	2.35	1.20	-12.25	0.36	8.1	20	0.04
Japan	1994-1998	0.94	4.86	3.55	5.83	-36.87	0.38	5.7	8	0.02
Netherlands	1990-2000	3.21	3.01	2.26	3.63	-1.35	0.35	6.4	9	0.15
Norway	1990-1999	3.10	3.50	3.31	10.41	-6.32	0.28	10.9	11	0.07
Spain	1990-1999	2.37	1.23	4.16	4.83	-17.67	0.35	6.6	19	0.04
Sweden	1990-2000	1.93	8.21	6.33	10.11	-14.19	0.30	6.6	13	0.07
United Kingdom	1990-2000	2.42	0.12	0.97	2.99	-12.07**	0.33	6.9	7	0.13
United States	1990-1999	3.11	3.71	2.96	3.05	-4.61	0.35	16.7	1	0.12

* The data "Number of Triadic Patent" are not available after 1998.

** Between 1990-1998.

Sources: OECD, MSTI, EVCA and own calculations

Ireland in these years had an aggressive policy to attract the investments using for example very low rates of taxation. Ireland, Sweden, Finland and Denmark have a strong tradition of investment in R&D what positions them since years as European examples (e.g. within the framework of the efforts to reach the Lisbon objectives). Most countries are around 3% of business R&D (capital stock) growth. The number of Triadic patents is low in France and Italy while Canada, Finland, Norway and Sweden are the best performers.

About the entrepreneurial environment, CITR is on average between 30% and 40% for ten countries. The labour market rigidity, as explained above, is proxied by the labour standard index. It refers to the strength of the legislation governing a number of aspects of the labour market. Since no modification occurred over the period under investigation, for each country, this variable takes a unique value. It is the same for the TEA-index.

As far as the percentage shares of VC intensity are concerned, Japan and Denmark are the least intensive countries with 0.02%. Australia, the Netherlands, United-Kingdom and the United States are around 0.10% and Canada is at the top with 0.18%.

3.5. Empirical results

As in chapter 2, the use of fixed effects is more adapted in our case since each country is assumed to have a specific effect on the VC intensity. Therefore, we carry out a test of Hausman to be sure that we can eliminate the random effects model. The statistic of test is equal to 1711.31 what is larger than the tabulated quantile value of the χ^2_{15} and thus we reject the random effects model. After this, we test using the Chow test if the country effect is the same of all the countries in the sample. In this case, the statistic of test is equal to 242.51 what is also larger than the tabulated quantile value of the χ^2_{15} and thus we reject this hypothesis[28]. Therefore, we carry out fixed effects estimations and we obtain different constants for each country eliminating data noise

[28] Breusch-Pagan: The statistic of test is equal to 8.33 that is higher than the tabulated quantile value χ^2_1 equal to 3.84 and then we reject the null hypothesis of null variances between countries. We thus do not use a pooled regression

related to cross-country differences. Moreover, the possible existence of a common macroeconomic factor affecting all countries' economies is taken into account by the introduction of time dummies. The GLS specification is applied because it permits us to correct a possible heteroscedasticity problem[29].

Each variable of Equation (3.5) has first been included separately in the empirical model. The estimated parameters are presented in Table 3.4. All variables have the expected impact, as far as their sign and significance of the coefficients are concerned. Results concerning the growth rate of GDP (Table 3.4, column 1) are in line with those of Gompers and Lerner (1998) for the USA but do not confirm the non-significant impact obtained by Jeng and Wells (2000). Several tests have been carried out in order to determine whether a time lag is necessary. However, only the contemporaneous GDP growth rate has a significant impact on VC intensity.

Interest rates have a positive and significant impact. This suggests that the demand-side effect of interest rates is stronger than the supply-side effect. It seems to indicate that even with increasing interest rates, the quantity of VC remains insufficient (the potential increase in VC price is not sufficient to attract more funds providers). Hence, an increase in interest rate will have a positive impact on the price of VC mainly due to the shortage of VC funds.

The three variables representing technological opportunity and research efforts play a significant role in determining VC intensity. The strong and positive impact of the growth rate of business R&D expenditures, the business R&D capital stock and the number of triadic patents show that the demand of VC is sensitive to the dynamics of research activities, to the available stock of knowledge and to the level of innovation output, as proxied by the number of high value patents.

The variable that yields the highest adjusted R-squared is the interest. Besides, GDP growth rate and the technological opportunity variables also explain a sizeable share of the dependent variable variability. The cost of money and technological opportunity seem to be the strongest drivers of VC.

[29] In this chapter, tests of exogeneity of the variable have not been carried out because it seems quite logical that the explanatory variables are not endogenous. Indeed, unless in extreme cases the business cycle is exogenous to VC intensity, as well as the interest rate and the level of corporate income tax rate. Concerning the technological opportunity, the three variables used in this model are lagged.

Table 3.4: Estimation results of the VC intensity, single explanatory variables

		Dependent variable: VC intensity (VC/GDP)					
Regressions		**1**	**2**	**3**	**4**	**5**	**6**
Economic variables							
GDP growth rate	ΔGDP_{it}	0.002***					
		(2.74)					
Interest rates	r_{it}		0.00005***				
			(4.13)				
Technological opportunity							
Business R&D investment growth rate (t-1)	ΔBRD_{it-1}			0.001***			
				(2.88)			
Business R&D capital stock (t-1) (*10^{-14})	$SBRD_{it-1}$				1.33***		
					(4.57)		
Log Number of triadic Patents (t-2)	$LPAT_{it-2}$					0.0003**	
						(2.24)	
Entrepreneurial environment							
Corporate Income Tax Rate	$CITR_{it}$						0.0004
							(1.20)
Control variables							
German reunification dummy (t)		Yes	Yes	Yes	Yes	Yes	Yes
Country-specific intercept		Yes	Yes	Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared		0.897	0.916	0.900	0.895	0.901	0.912

Note: Panel data, 16 OECD countries, 1990-2000, 154 observations. * Indicates the parameters that are significant at a 10 probability threshold, ** 5 probability threshold and *** 1 probability threshold. The econometric method is GLS. T-Statistics in parentheses.

Table 3.5: Estimation results of the VC intensity, complete model and interactions

Dependent variable: VC intensity (VC/GDP)							
Regressions		**1**	**2**	**3**	**4**	**5**	**6**
Economic variables							
GDP growth rate	ΔGDP_{it}	0.002* *(1.67)*	0.003*** *(3.17)*	0.009*** *(3.68)*	0.002** *(2.07)*	0.002** *(2.46)*	0.009*** *(3.72)*
Interest rate	r_{it}	0.00004** *(2.35)*	0.00005*** *(3.01)*	0.00004*** *(2.56)*	0.00005*** *(3.51)*	0.00005*** *(3.54)*	0.00004*** *(2.99)*
Technological opportunity							
Business R&D investment growth rate (t-1)	ΔBRD_{it-1}	0.0006* *(1.68)*					
Business R&D capital stock (t-1) (*10^{14})	$SBRD_{it-1}$	1.43*** *(4.47)*	1.23** *(3.99)*	1.07*** *(3.43)*	1.36*** *(3.92)*	-1.42** *(-2.40)*	-1.23** *(-2.19)*
Log Number of triadic Patents (t-2)	$LPAT_{it-2}$	0.0003** *(2.31)*					
Entrepreneurial environment							
Corporate Income Tax Rate	$CITR_{it}$	-0.0002 *(-0.50)*	0.00002 *(0.07)*	0.00004 *(0.12)*	-0.0003 *(-0.80)*	-0.0002 *(-0.60)*	-0.0001 *(-0.48)*
Labour Market Rigidities	$\Delta GDP_{it} * RIG_i$			-0.0006*** *(-2.69)*			-0.0006*** *(-2.99)*
Labour Market Rigidities (*10^{-14})	$SBRD_{it-1} * RIG_i$				-1.35*** *(-2.53)*		
Level of entrepreneurship (*10^{-15})	$SBRD_{it-1} * TEA_i$					1.70*** *(3.90)*	1.51*** *(3.53)*
Control variables							
German reunification dummy (t)		Yes	Yes	Yes	Yes	Yes	Yes
Country-specific intercept		Yes	Yes	Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R-squared		0.939	0.939	0.939	0.898	0.933	0.945

Note: Panel data, 16 OECD countries, 1990-2000, 154 observations. * Indicates the parameters that are significant at a 10 probability threshold, ** 5 probability threshold and *** 1 probability threshold. The econometric method is GLS. T-Statistics in parentheses.

Table 3.5 presents the results of the estimates with several variables introduced simultaneously in the model. The sign and significance of the impact of all these variables remain unchanged when they are introduced simultaneously in the model except for the business R&D investment growth rate.

Column 1 presents the basic model described in Equation (3.5). As already shown in the previous table, the variables representing technological opportunity play a significant role in determining VC intensity. The parameters associated with the business R&D capital stock and the number of triadic patents, are positive and significant. This result about triadic patents is consistent with the results of Kortum and Lerner (1998) or Tykvova (2000) who show that a surge of patents may increase the VC fundraising. In other words, the property of highly valued intellectual assets (triadic patents are associated with a much higher value than the patents applied only in one country or region) seems to stimulate the demand for VC.

The remaining columns test other specifications described in Equation (3.6), with two interaction variables representing a country's entrepreneurial environment. The index of labour market rigidities is first interacted with the GDP growth rate variable (see column 3). The results suggest that the impact of GDP growth rate on the VC intensity is composed of a fixed positive and significant component (0.0092) and a country specific component that depends on labour market rigidities (-0.00057). The positive impact of GDP on the VC intensity is therefore reduced in countries with high labour market rigidities. Jeng and Wells (2000) obtain a similar result but only for early stage funding. Over the threshold of 16.14 in the index of labour market rigidities, the impact of GDP growth becomes negative. Column 4 presents the estimated parameters related to the interaction between labour market rigidities and the stock of business R&D. Again, we find a negative and significant impact of the interaction term. The impact of business R&D capital stock becomes negative over the threshold of 10.07 in the index of labour market rigidities.

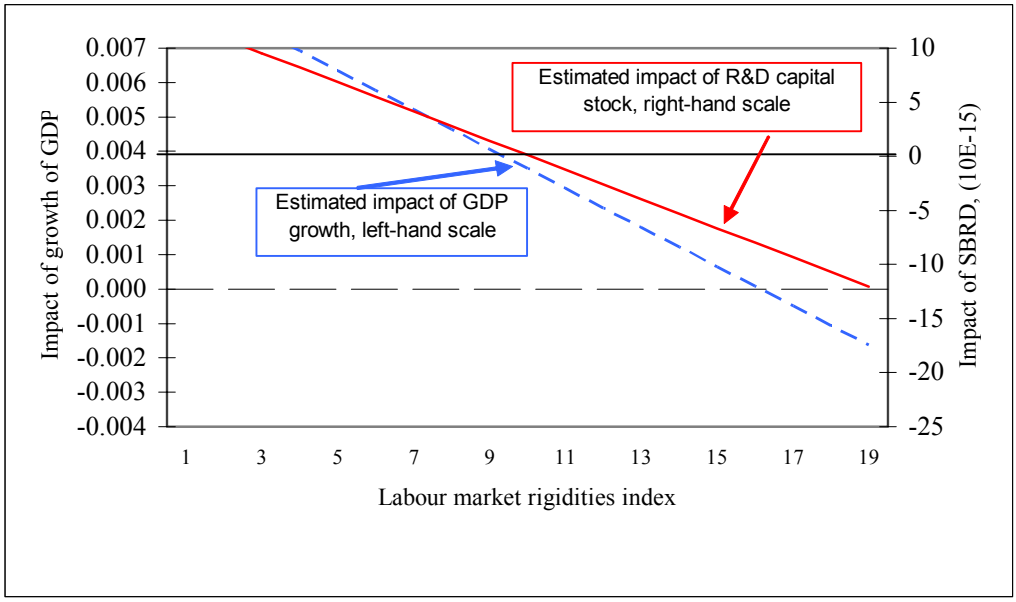
The level of entrepreneurship is interacted in a similar way with the stock of available knowledge (the R&D capital stock, in column 5). Estimates indicate that the impact of the R&D capital stock on the VC intensity is composed of a fixed negative component and a country specific component that depends on the relative level of entrepreneurship (TEA): the higher the level of entrepreneurship, the stronger the impact of the business R&D capital stock on VC intensity. The estimated parameters suggest that the impact of the business R&D capital stock on the VC intensity

becomes positive and significant above a threshold of 8.35 in the TEA index (level of entrepreneurship). Hence, it seems that a minimum level of entrepreneurship is required in order to have a positive impact of the available stock of knowledge on VC performances.

The estimated parameters associated with the interaction between the two country-specific variables representing the entrepreneurial environment are stable. Column 6 shows that the simultaneous introduction of the two indicators (RIG and TEA) yields jointly significant parameters.

Figure 3.2 illustrates the results of the interactions ($\Delta GDP_{it} * RIG_i$ and $SBRD_{it-1} * RIG_i$) as estimated from Equation 3.6[30,31]. It shows how the level of labour market rigidities affects the impact of two determinants of VC. The impact of the stock of knowledge and of the GDP growth rate decreases with an increase of labour market rigidities. They become negative over a threshold of 10 and 16 respectively.

Figure 3.2: The indirect effect of labour market rigidities on VC



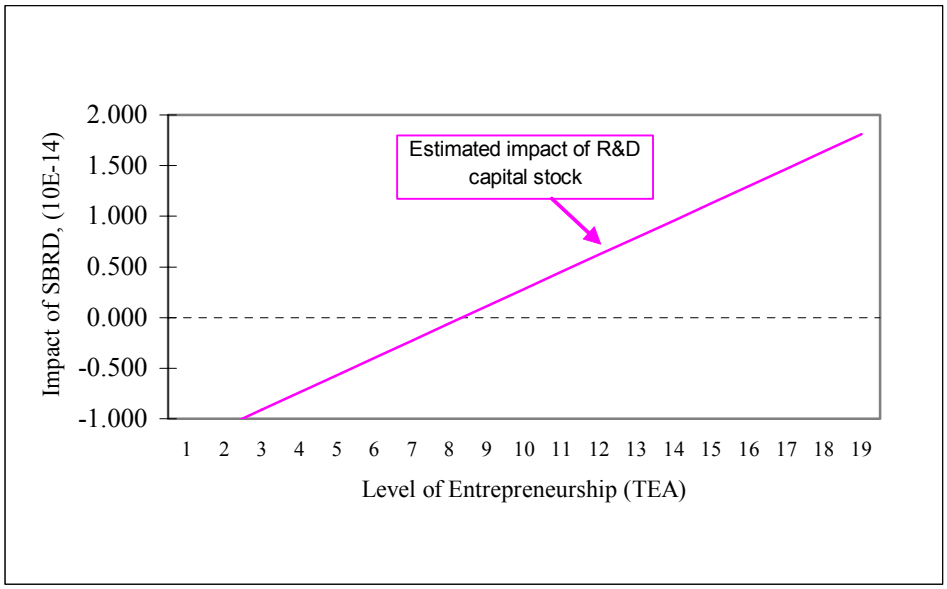
Note: Estimated impact of the growth rate of GDP and the stock of knowledge on VC intensity, according to the level of labour market rigidities. See Table 3.5, columns 3 and 4.

[30] Results are presented in Table 3.5 (columns 3 and 4).

[31] Due to our specification, the presented interactions have a linear shape. Alternative non-linear specifications could also be investigated in further research.

Figure 3.3 also illustrates the result of the interaction ($SBRD_{it-1} * TEA_i$) as estimated from Equation 3.6[32]. It shows how the level of entrepreneurship affects the impact of the stock of knowledge. They become positive over a threshold of 8.

Figure 3.3: The indirect effect of level of entrepreneurship on VC



Note: Estimated impact of the stock of knowledge on VC intensity, according to the level of entrepreneurship. See Table 3.5, column 5.

Table 3.6 summarizes the main findings of our empirical investigation and compares them with the results obtained by Jeng and Wells (2000) and Gompers and Lerner (1998). The cyclicality of VC with respect to GDP growth confirms both our expectation and the results of Gompers and Lerner. The reason why Jeng and Wells did not find any significant effect could be the use of the IPO variable in addition to GDP.[33]

Concerning the cost of capital, we confirm the positive impact of the interest rate obtained by Gompers and Lerner at the aggregated level.

[32] Result is presented in Table 3.5 (column 5). The previous comment concerning the linear shape of the graph is also applicable here.

[33] The two variables could be correlated in their sample.

Table 3.6: Comparison of our results with the state of the art

	Jeng and Wells (2000), 21 countries, Panel data and cross section	**Gompers and Lerner (1998) US industry aggregated data**	**Our analysis 16 countries, panel data**
Macroeconomic conditions			
Gross domestic Product	0	+	+
Interest rate 1 year		+ at aggregated level and – at state level	+
Private Pension Funds	+ Over time 0 Across countries	+ Over time	
Entrepreneurial environment			
Taxation rate	0	-	0
Labour market rigidities	- at the early stage; 0 at expansion stage		- they reduce the impact of GDP and R&D on VC
Initial Public Offering	0 at early stage across countries; + at expansion stage	0	
Stock Market Opportunities	(Market Capitalization Growth) 0	(Equity Market Return). +	
Level of entrepreneurship			+ Increases the impact of R&D on VC
Technological opportunity			
Number of Triadic Patents			+
Business R&D growth		+	+
Stock of knowledge		+	+

Labour market rigidities reduce the intensity of VC. On the other hand, a strong entrepreneurial culture and more intense technological opportunities and research efforts improve the positive effect of the stock of knowledge on the VC intensity. Moreover, the property of highly valued intellectual assets seems to stimulate the demand for VC.

3.6. Concluding remarks

This chapter's investigates the determinants of VC intensity. Our contribution to the existing literature consists in first, developing a theoretical model that takes into account the supply-side and demand-side variables to explain VC intensity; and second, introducing simultaneously traditional determinants of VC and new potential determinants such as the cost of capital, the level of entrepreneurship, and novel proxies aiming to measure technological opportunities (i.e. the number of triadic patents).

The main empirical results can be summarized as follow:

Concerning macroeconomic conditions, interest rates have a positively significant impact on VC intensity via a strong demand-side effect, indicating that an increase in interest rate will have a positive impact on the price of VC mainly due to the shortage of VC funds. Moreover, VC is pro-cyclical: it follows a similar evolution than GDP growth rate. In periods of high growth, the flow of venture capital outperforms the GDP growth rate, and *vice versa*. This cyclicality is reduced by the degree of labour market rigidities. A high level of labour market rigidity reduces the positive impact of GDP growth on VC intensity, as well as the positive impact of the knowledge capital stock on VC.

The most important contribution of this chapter concerns the technological opportunity aspects. Indeed, results show that indicators of technological opportunity are critical for VC development. The available stock of knowledge and the number of high value patents (triadic patents) influence significantly the amount of VC invested in a country's economy. The positive impact of the stock of knowledge is strongly reinforced in the countries where the rate of entrepreneurship is very high.

One important policy implication that emerges from these results is that, in order to stimulate VC in a country, demand-side factors have to be taken into account. The

most important factors affecting the demand of VC are the stock of knowledge, innovative outputs proxied by the number of triadic patent. Labour market rigidities and the level of entrepreneurship also play an important role. Strategies aimed at exerting leverage on these factors would require adjustment in structural policies (labour market and education) whose impact can only become apparent in the long term.

PART 2: TECHNOLOGY-BASED SMALL FIRMS

CHAPTER 4:

TECHNOLOGY-BASED SMALL FIRMS - EMPIRICAL IMPLEMENTATION AND SURVEY IN BELGIUM

4.1. Introduction

The relatively low level of entrepreneurial culture in Europe, and particularly in Belgium, in comparison with the United States has been pointed out by the Venture Capital (VC) intensity and the Total Entrepreneurial Activity index presented in the GEM report (Acs *et al.*, 2004). This lack of entrepreneurial culture probably originates from social and educational culture as well as from micro features and macro-economic environment. In other words, a lot of country's characteristics exert an effect on the level of entrepreneurship such as the research and development (R&D) activities, physical, commercial and professional infrastructure, public policy, and financial markets.

However, this level of entrepreneurship is important and particularly for high-tech industries. Technology-Based Small Firms (TBSF) help guarantee the future economic performance of an industry, a nation, and of the TBSF themselves. However this assertion is true only provided that they survive and develop. TBSF are part of the companies with the highest growth potentials in the middle and long term (Weigand and Audretsch, 1999). Certain new companies in more traditional industrial sectors whose innovative character is not 'high-tech' also benefit from high growth. However, these companies generate less positive externalities to the rest of the economy. Indeed, high-tech companies generate

knowledge, competences and a demand for quality services and intermediate products that have significant repercussions on the rest of the economy. Moreover, they are able to establish and maintain relationships with universities and research laboratories, sources of future innovations.

In order to get a quantitative insight into the entrepreneurial growth process in Belgium, a survey of technology-based small firms was launched in 2002. The survey focuses on subjects that relate to three factors of entrepreneurial development: the framework conditions, the socio-cultural factors associated with the entrepreneurs and their environment, and the financial system.

The purpose of the present chapter is to present the existing literature on the performance of companies and to describe the methodology of the survey. This survey has two merits. The first one lies in the quality of the information. Indeed, most of national and international surveys have been developed at firm-level. There exist only a few surveys at founder-level. In the TBSF database, you will find information both at firm and at entrepreneur-level. The second merit is about the subject covered. A lot of surveys focus on innovation (Community Innovation Survey-CIS, 1993, 1997, 2001), while others try to understand the financing of firms (Giudici and Paleari, 2000). The focus of our survey is larger. TBSF survey tackles the financing of firms (availability of public funds, role of venture capitalists, availability of business angels,…), the framework conditions (e.g. the quality and availability of infrastructures and communication channels, the level of academic and public research, the patenting process,…) and, finally, the socio-cultural factors associated with the entrepreneurs and their environment (e.g. level of education, their parent's education, gender,…).

This chapter is structured as follows. Section 4.2 focuses on existing empirical literature on the development of firms. Three categories of determinants are reviewed: company-specific characteristics, founder-specific characteristics, and financial characteristics. Section 4.3 describes the construction of a new database on Belgian TBSF. After briefly reviewing past initiatives in terms of entrepreneurial surveys at firm-level, section 4.4 outlines the questionnaire constructed to investigate on the three factors of entrepreneurial development. Section 4.5 discusses the way the survey was carried out and section 4.6 concludes.

4.2. Existing empirical research

This section focuses on the abundant empirical research already conduced on the performance of companies.

4.2.1. Variable of performance

Existing studies on the development of companies differ strongly regarding the variables used to represent the companies' performance. Table 4.1 displays the variables most often used in the recent empirical literature.

Bates (1990), Cressy (1996), and Nafziger and Terrell (1996) use a dummy equal to 1 if the company is still in activity at the time of the study and 0 if not. The limitation of this kind of variable is that it enables to compare only two states of a company: company still in activity versus company that went bankrupt. Some authors refine this variable by adding additional information such as the time of survival of companies (Brüderl *et al.* 1992) or the fact that they still have positive incomes, in addition to being in activity (Montgomery *et al.* 2000).

In order to build quantitative non binary (e.g. turnover, total assets) or qualitative (e.g. strong growth, weak growth, constancy, decrease) indicators of companies' development, other types of information must be used, such as, for example, the growth rate of the number of employees, in absolute growth, or in level.

In their econometric analyses, Jo and Lee (1996) and Almus *et al.* (1999) use the growth rate of employment as dependent variable. Almus *et al.* show innovative companies have a higher employment growth rate than non-innovative companies. Mata (1996), Colombo and Grilli (2005a), and Barkham (1994) on the other hand use as for them a variable of employment level. Mata (1996) studies the factors that influence the size of companies. He finds that the size of companies (approached by the number of employees in logarithm) increases with the level of education of the entrepreneurs. Colombo and Grilli also find a strong link between human capital and employment. Highly qualified persons with entrepreneurial capacities positively influence their company's employment. According to Barkham (1994), entrepreneurs who create the most jobs are

strongly motivated, have good management capabilities, and run companies active in the manufacturing sector.

Table 4.1: Performance variables (non-exhaustive lists)

Development variables	**Papers**
Dummy for survival	Bates (1990) Brüderl *et al.* (1992) Cressy (1996) Nafziger and Terrell (1996) Montgomery *et al.* (2000)
Number of employees	Barkham (1994) Mata (1996) Jo and Lee (1996) Manigart (1996) Almus *et al.* (1999) Colombo and Grilli (2005a)
Turnover / Sales	Miller and Toulouse (1986) Acs and Audretsch (1990) Barkham (1994) Manigart (1996) Delmar (1999) Harada (2003) Cassar (2004)
Total Assets	Barkham (1994) Manigart (1996) Jo and Lee (1996)
Result after tax	Miller and Toulouse (1986)
Added value	Manigart (1996)

Another widespread representation of a company's performance is the amount of sales. Miller and Toulouse (1986), Acs and Audretsch (1990), Delmar (1999), and Manigart (1996) use the growth rate of sales as dependent variable in their quantitative analyses. Manigart finds that the higher the financial assets the lower the growth rate of sales. Barkham (1994), on the other hand, studies the determinants of the logarithm of turnover realized during the third year of existence of a company. His results show that the turnover is higher if there are several founders who have experience in management or in sale, are motivated to

grow quickly, and have a good knowledge of the market. Harada (2003) tests a measure of success that is more subjective. He uses an indicator equal to 1 if achieved sales exceed sales that were expected by the founder when starting the company. The author shows that the age of the founder, his former professional experience in trade and management, and the initial size of the new company, have a positive impact on the success indicator. Cassar (2004) uses a somewhat similar measure of size intention: logarithm of the intended future firm sales in 5 years. He tries to understand how intended future firm sales revenue is influenced by entrepreneur current household income, education, and managerial experience and shows that individuals with higher current household income and greater supervisory experience have higher levels of intended firm size in 5 years time.

Barkham (1994) uses the variable 'total assets' to study the size of new companies. He shows that total assets (just like turnover) are higher if there are several founders who have experience in management or sales, are motivated to grow quickly, and have a good knowledge of the market. A Belgian study of Manigart (1996) tests the impact of financial characteristics on companies' total assets. It shows that a higher proportion of cash leads to a higher growth rate of total assets. Conversely, neither the legal form of companies nor other financial variables have a significant effect.

The result after tax of a company also gives an indication of its performances. Miller and Toulouse (1986) test the impact of explanatory variables on several indicators of growth performance, among others the growth rate of net income. Using survey data of 97 Canadian companies in various sectors of activity, the purpose of their study is to assess the impact of the strategy, the structure, the style of decision-making and the personality of the CEO (Managing Director) on the performance of small companies. The main finding of this study is that the correlation between growth and profitability is strong for small companies with an innovative position on the market and a more aggressive and analytical decision-making process guided by an explicitly codified strategy. They find that better performance is also linked to the CEO delegating the decision-making process and surrounding himself by qualified directors and experts. According to the authors, the flexibility of the CEO generally has a positive impact on performance whereas the time in years he spent in his function is negatively correlated with the majority of performance indices.

Other variables tested than those presented in this literature review are the average growth rate of return on investment (Miller and Toulouse, 1986), the labour productivity (Jo and Lee, 1996) or, (as Reid and Smith, 2000), a subjective variable of performance (good, medium, low). The probit model used by Reid and Smith shows that two factors are very important for companies' performance: long-range planning (rather than formalised business plan) and pursuit of pecuniary goals (rather than lifestyle goals). Based on their SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) Reid and Smith conclude that the best entrepreneurs in terms of jobs creation are conscious of their capabilities since they do not exaggerate their forces and opportunities and do not underestimate their weaknesses and difficulties.

Table 4.1 shows that studies on the determinants of companies' performance use many different indicators. Janssen (2004) studies whether these variables are interchangeable. He shows that employment and sales are in fact not identical approximations of the concept of companies' development because they are determined by different factors. He concludes that many inconsistencies encountered in the empirical literature result from this problem.

Factors that influence companies' performance can be grouped into three categories: financial determinants (such as VC, and governmental support), company-specific and environmental factors (characteristics of the company, R&D, patents, collaborations, environment and market conditions), and founder-specific factors (such as demographic characteristics, education, and professional experience).

4.2.2. Factors influencing companies' performance

Financial determinants

The role that **access to financing** sources can play for entrepreneurs' success is largely debated in the literature. According to Gompers and Lerner (2001a), innovation creates value only when companies manage to attract the necessary resources to support their development and fast growth. This explains why the lack of financial resources is one of the biggest problems faced by high-tech start-

ups. Colombo and Grilli (2005a) investigate the role of external financing on firms' start-up size. With a sample of 391 Italian new technology-based firms, they find that bank debt-financed firms are not larger than firms created only through founders' personal savings. They also find that only few sample firms got access to private equity financing but the provision of this type of financing had a strong positive effect on start-up size. However, it should be noted that the study of Manigart (1996) does not show any significant impact of financial variables on the growth of Belgian companies for example growth in terms of number of personnel employed.

Authorized capital as financial indicator, can be used as an approximation of the initial size of a company. In his analysis of the success factors of entrepreneurship, Harada (2003) uses this variable to assess the impact of initial size on the chances of success of new Japanese companies. His results tend to show that the authorized capital of a company has a positive impact on its future profits and sales. For Cooper *et al.* (1994), the size of the start-up initial capital contributes to the survival and growth of the company. Again, Manigart (1996) does not find any impact of this variable on the development of Belgian companies.

Another potential problem for entrepreneurs relates to the **inadequacy of the types of funding** available. With data on Italian companies, Giudici and Paleari (2000) show that the traditional sources of funds are in fact inadequate to finance highly innovative projects.

Finally, an increasing number of empirical studies describe the crucial importance of **Venture Capital** (VC) and its impact on the growth of high-tech start-ups (Engel 2002, Davila *et al.* 2003). Hellemann and Puri (2002) argue that venture capitalists intervene in a wide number of activities that are important to the professionalization and the development of a start-up company (i.e. managerial advice, strategy formulation, communication skills, the formulation of human resources policies and the adoption of stock option plans etc.). Manigart and Van Hyfte (1999) illustrate its impact on the survival of companies.

Company-specific factors

The **size of the company** as a catalyst of future development is an extremely widespread field of research. In his study on young Japanese companies, Harada (2003) shows that the initial size of a Japanese firm has a positive impact on its future success. Larger companies tend to have a higher probability of success. According to Agarwal and Audretsch (1998), small companies have a lower probability of survival, except for mature high-tech products for which an opposite effect is observed. Indeed, in those markets where entry targets a strategic niche rather than the large exploitation of a radical innovation, there is an inversion of the impact of size on the probability of survival of the company.

Innovation factors are also relatively common in existing literature. R&D and patents are prevalent factors in the development of innovations by firms. Acs and Audretsch (1988) find that the number of innovations increases with the increase in R&D expenditures, but at a decreasing rate. Patents add value to the intangible assets of a young innovative company. Moreover, they are a legally enforceable protection mechanism against imitation and constitute an additional source of income through royalty payments.

Finally, **environmental factors** such as entrepreneurial infrastructure or entrepreneurial culture are very important. Suzuki *et al.* (2002) compare supporting infrastructures (professional services, availability of financial resources and support from various institutions) of start-ups based in Japan and in *Silicon Valley* (United States). They conclude that *Silicon Valley* enjoys better entrepreneurial infrastructure than Japan concerning institutional support, professional services and more funds from private VC but Japanese companies have at their disposal greater diversity of financial sources. They argue that the entrepreneurial activities of an area reflect the business climate and importance of innovation in this area. Feldman (2001) explains that the existence of authorized capital, the availability of venture capital, the availability of support services to the entrepreneurs as well as research collaboration with universities reflect the success of the establishment of an entrepreneurial culture rather than the conditions and context associated with the genesis of entrepreneurship.

The **localization** could have a positive impact on the development of high-tech small companies, particularly in the surroundings of institution full of human

capital. Indeed, in their study of the biotechnology industry Zucker *et al.* (1998) show that the growth and localization of intellectual capital are the main determinants of growth and localization of the industry itself. According to Engel and Fier (2000), the availability of human capital is also an important determinant of the success of entrepreneurial activities based on high-technology. They show that high-tech start-ups in Germany are founded in areas well served by scientific infrastructures. More precisely, the importance of human capital in universities would explain the regional concentration of high-tech start-ups. They find that areas with many institutions of higher education in the fields of engineering and data processing are of particular interest for start-ups in very high-technology sectors and in technology intensive services sectors. High-technology sectors and non-technical consultancy services would prefer to settle in an area where institutions of higher education in the field of sciences are located.

Founder-specific factors

Penrose (1959) described a company as a whole of physical and human resources in which the availability and the quality of managerial resources are sources of growth.

Many studies have analysed the impact of **human capital** on the growth of companies (Bates, 1990; Montgomery *et al.*, 2000; Markman and Baron, 2003; DeMartino and Barbato, 2003; Anderson and Miller, 2003; Aldrich and Cliff, 2003; Baum and Silverman, 2004; Colombo and Grilli, 2005b). They reveal the strong importance of the level of education and professional experience of the founders in the survival and the growth of companies, especially in high-tech industries. According to Harada (2003), the professional experience of an entrepreneur in a start-up has a positive impact on its future growth whereas the age and the female gender are negatively correlated with the chances of success. His result concerning the age is in contradiction with the human capital assumption of Cressy (1996), which suggests that the age of founders should have a positive impact on success of entrepreneurial activities.

In addition to gender, age and professional experience, other **personal factors** explain the growth of technology-based small firms, such as matrimonial statute,

level of education and family background of entrepreneurs (education and professional experience of their parents).

With regard to motivations, Suzuki *et al.* (2002) and Herron and Robinson (1993) identify a number of individual factors that can lead somebody to become an entrepreneur, such as personality, capabilities and values. Suzuki *et al.* suggest that entrepreneurial motivations differ from one area to another. For example, Japanese entrepreneurs are firm-oriented whereas entrepreneurs in *Silicon Valley* are motivated by individual factors such as personal achievement and accumulation of personal wealth.

In a nutshell, the analysis of existing studies on determinants of performance does not enable to define a standard profile of a successful entrepreneur. These studies do not describe either a particular type of company or adequate environment for the growth of high-tech companies. Nevertheless, they suggest a certain number of characteristics that can prove to be valuable for the growth of TBSF. In order to implement this literature on technology-based small firms in Belgium, we try to address these different concepts in a nation-based survey. The next section presents the database of Belgian TBSF. In the section there after we present the method we used in conducting the survey.

4.3. The Belgian TBSF database

Technology-based small firms are innovative enterprises also widely known as high-technology start-ups. As we were not aware of an existing published or created Belgian high-technology firms' directory, in 2002, we created a new database directory of Belgian TBSF. The TBSF Database consists of four parts.

- Part 1 contains the Belgian companies that meet the technology-based and size criteria (see below). This part can be considered as the address book including the recipients of the questionnaires.

The three last parts were created in a second stage, after receiving the answers from the entrepreneurs.

- Part 2 includes the company profile as well as information about patents and research.
- Part 3 joins all the financing information.
- Part 4 contains the results about the entrepreneur/founder characteristics.

The four parts are linked together by a single key number per company. This key number set in the address book is used to create and maintain company information in the 3 additional parts on company profile, financing and the entrepreneur/founder.

We constructed the address book in 3 steps. Step 1 is based on the definitions of technology-based and "small" firms established in the 3 Belgian regions: Brussels-Capital, Flanders, and Wallonia. Step 2 covers the identification of technology-based small firms using a wide range of sources. Finally, Step 3 involves the physical entry of enterprises into the TBSF Database.

4.3.1. Step 1: Definition of TBSF

The address book is being created according to the OECD revision of the high-tech sector definition (Hatzichronoglou, 1997). The study includes companies classified as "High-Technology" and "Medium-High-Technology" according to OECD classification (Table 4.2).

The high-technology firms in the TBSF Database include Belgian companies operating in aerospace, computers and office machinery, electronics and telecommunications, and pharmaceuticals.

The medium-high-technology firms in the TBSF Database include Belgian companies operating in the sectors of scientific instruments, electrical machinery, chemicals, non-electrical machinery, motor vehicles and other transport equipment.

Table 4.2: OECD industry classifications based on technology intensity

High-technology	CITI Revision 2
1. Aerospace	3845
2. Computers, office machinery	3825
3. Electronics-communications	3832
4. Pharmaceuticals	3522
Medium-high-technology	
5. Scientific instruments	385
6. Motor vehicles	3843
7. Electrical machinery	383-3832
8. Chemicals	351+352+3522
9. Other transport equipment	3842+3844+3849
10.Non-electrical machinery	382-3825
Medium-low-technology	
11. Rubber and plastic products	355+356
12. Shipbuilding	3841
13. Other manufacturing	39
14. Non-ferrous metals	372
15. Non-metallic mineral products	36
16. Fabricated metal products	381
17. Petroleum refining	351+354
18. Ferrous metals	371
Low-technology	
19. Paper printing	34
20. Textilee and clothing	32
21. Food, beverages, and tabacco	31
22. Wood and furniture	33

Source: OECD, 1997.

We use the definition of a small firm adopted by the European Commission (EC, 1996 and 2003). The EC focuses on measurable parameters of size (number of employees, annual sales or turnover, balance sheet total and control, according to which less than 25% of equity should be owned by one or a joint enterprise).

Small firms according to EC definition of 1996[34] have fewer than 50 employees and have either an annual turnover not exceeding € 7 million or an annual balance-sheet total not exceeding € 5 million. Since 2003, the definition has

[34] Commission Recommendation of 3 April 1996 concerning the definition of small and medium-sized enterprises (96/280/EC) [Official Journal L 107 of 30/04/1996]

changed[35] and small companies are those who employ less than 50 employees and have either an annual turnover not exceeding € 10 million or an annual balance-sheet total not exceeding € 10 million.

4.3.2. Step 2: Identification of TBSF

We employed a combination of methods to collect company information. These methods include: internet search, private and confidential listings from sources of information (i.e. FEDICHEM, AGORIA and BVA), interviews with managers (i.e. m-Brussels), member directories (i.e. IMEC, VIB, AGORIA, EVCA and BBA), Belgian companies database (i.e. BEL-FIRST), and publications (i.e. IMF, Eurostat and OECD).

The sources of information and access links used to create the company address book are presented in Appendix 9.2, pages 177-178.

We identified 650 companies operating in manufacturing and/or service industries as outlined above. Subject to availability of information, companies are entered into the address book in 3 subsections.

Section 1 - Company header details include company name, legal form of establishment, year of establishment, Belgian VAT number, mailing address, postal area (zip) code, phone number, fax number, e-mail, and web address.

Section 2 - Contact person(s) details includes full names and positions of senior manager that personalized letters along with the questionnaire were planned to be mailed.

Section 3 - Survey follow-up management, aims to keep track of the surveying logistics and includes key information such as the date of mailing, the language of the questionnaire, the follow-up reminder and means of reminder (i.e. telephone, e-mail, mail, and fax).

[35] On 6 May 2003 the Commission adopted a new Recommendation 2003/361/EC regarding the SME definition which replaced Recommendation 96/280/EC as from 1 January 2005 [Official Journal of the European Union L 124 of 20/05/2003]

A unique company number (key) set in the address book is used to create and maintain company information in the 3 additional parts on the company profile, the financing and the entrepreneur/founder.

4.3.3. Step 3: Physical entry

We entered 607 enterprises out of 650 into our newly created TBSF database as 43 enterprises were found to be out of target or were no longer active in business in December 2002. Hence these 607 companies represent the total population of TBSF in Belgium.

4.4. The questionnaire for TBSF

4.4.1. Existing surveys on firms

Surveys on entrepreneurial issues are developed in a lot of countries. They mainly focus on financing and the innovation activities of firms.

At the national level, Germany stands as a good example for the rest of Europe. The ZEW institute (Centre for European Economic Research) has achieved the systematic encoding of information on innovative start-ups. They are working together with the Germany's largest credit rating agency Creditreform[36]. The ZEW institute establishes several databases and updates these regularly. The ZEW start-up panel for West and East Germany contains firm level data for analysing business start-ups, growth, and failure. The panel includes information on about 7 300 000 firms. The Mannheim Innovation Panel (MIP) is a database on the innovative activities of companies in Germany, based on an annual survey. As far as Business Survey in the ICT-Intensive Sector is concerned, their data display results from quarterly surveys of companies of the ICT-intensive services sector on their present and future expectations with regard to their

[36] http://www.creditreform.de/Deutsch/Creditreform/index.jsp

economic situation. They have also made a survey of spin-offs from Universities and government-funded research institutes.[37]

The UK also tries to gather good information on their technology-based firms. The Bank of England (Brierley, 2001) studies the financing of technology-based firms. Cambridge University carried out a survey in 1995 on high-tech firms in the Cambridge and Oxford regions. The dataset consists of replies from 100 respondents pertaining to research-intensive firms. A lot of publications are based on this panel (for example: Keeble and Lawson, 1998; Keeble and Moore, 1997).

In France, an annual survey on the structure of firms (Enquête Annuelle d'Entreprise - EAE) is handled by the Ministry of Economy, Finance and Industry (INSEE - National Institute for Statistics and Economic Studies and the SESSI – Service of Industrial Statistics and Studies). The survey focuses on all companies of 20 employees and more in France, which represented 20 719 companies in 2004. This survey contains data on firm accountancy, production, investments, employment and occupation, across all industries.[38]

In Italy, Giudici and Paleari (2000) analysed the TBSF access to finance. They based their study on a national survey. They focused on SMEs and their sampling consists of 249 small high-tech Italian firms. The questionnaire focused mainly on the financial constraints of these firms and they received 46 answers. The results highlight that traditional financial sources are inadequate to finance innovative projects. In the relation to their lifecycle, firms prefer self-financing over debt, and debt over external equity financing.

Finland, Thailand, US and other countries also have surveys on new technology-based firms. (see for example Van Auken (2001) for a study that examines the financing of small technology-based firms in the US)

[37] For more information about ZEW databases, see Almus M., D. Engel and S. Prantl (2000), "The Mannheim Foundation Panels of the Centre for European Economic Research (ZEW"), ZEW Dokumentation Nr. 00-02, Mannheim.

[38] http://www.industrie.gouv.fr/observat/chiffres/sessi/secteurs/pdf/questionnaire_eae.pdf

At the international level, the Global Entrepreneurship Monitor (GEM) is well known. Country reports are available each year, since 1999, for a sample of countries[39]. This sample grows steadily in size. In 1999 there were 10 countries included, 21 in 2000, 29 in 2001 and 37 in 2002. GEM 2005 will conduct research in 39 countries. GEM creates a benchmark between countries even if it does not focus only on technology and innovating start-ups. A second strength of this database is the availability of information at the person-level (sex, age, education, marital status, size of household, employment status, income, whether the interviewee is the owner of a firm that is currently actively run by her or him, or whether she/he is currently engaged in starting an own business). The objective of the GEM analysis, based on a comparable evaluation of the level of national entrepreneurial activity for all participating countries, involves the exploration of the role of entrepreneurship in national economic growth. GEM proposes global comparisons, national reports, and special topic reports (as report on women and entrepreneurship - Minniti, Allen and Langowitz, 2006) based on the annual data collection cycle. As already explained in chapter 3, we have to keep in mind that the GEM database has some weaknesses. First, the GEM study fails to differentiate high-technology start-ups from other medium-low technology companies. Second, this survey is conducted using computer-assisted telephone interviews of a random sample of people. GEM considers nascent entrepreneurs as people who are actively involved in starting a new business that belongs to them.

Another international survey is the Community Innovation Survey (CIS). This questionnaire on innovation, usable in most EU countries, has been carried out for the first time in 1993 and takes place every four years (1997, 2001 and around 2005). The CIS questionnaire is based on the "Oslo Manual" jointly published by Eurostat and the OECD. Every state included in this study collects the national or regional data. The objective of this survey is the collection of firm-level data on innovation activities, like the part of turnover allocated to innovation, the part of budget used for innovation expenditures, the sources of information for

[39] For examples of reports see Manigart, Clarysse, Crijns and Gossens, (2001); De Clercq, Manigart, Clarysse, Crijns, De Sutter and Verzele, (2002); De Clercq, Manigart, Crijns, Clarysse, Verzele and Zegers (2003); Reynolds, Bygrave, Autio and others (2003).

the firms, the barriers to innovation, etc. The CIS allows the monitoring of the European progress in the area of innovation (cfr. objective of Lisbon summit, 1997) and to perform high quality analyses of the effect of innovation on economic growth, employment, etc.[40] As we are working on technology-based firms, innovation is a key issue.

In Belgium, data on TBSF are not easy to find. Concerning the innovation aspects, Peeters and van Pottelsberghe (2003) launched a Belgian survey similar to the French survey realized in 1997 by the SESSI (Service of Industrial Statistics and Studies, French Ministry of Industry) on the identification and measurement of competences coming into play in the innovation process.

The questionnaire of Peeters and van Pottelsberghe (2003) on the innovation competencies helps us conceive our survey. Though their survey was focused on large companies in Belgium, our questions about innovative activities are adapted to TBSF. For the financing part of the questionnaire, we take the example of Manigart and Struyft (1997) who have made up a national survey on the financing of 18 high-technology start-ups in Belgium. In order to complete this financing section, we also relied on the literature survey realised by the Bank of England (Brierley, 2001). Finally, the questions on the characteristics of entrepreneurs/founders are based on existing empirical analyses in the economic literature such as Bates (1990), Cressy (1996), Jo and Lee (1996), Harada (2003).

In order to make a resource-based typology of RBSU a database on 76 research-based start-ups in Flanders has been developed by Heirman *et al.* (2003). They find four typologies of starting configurations: "Venture capital-backed start-ups", "Prospectors", "Product start-ups", and "Transitional start-ups".

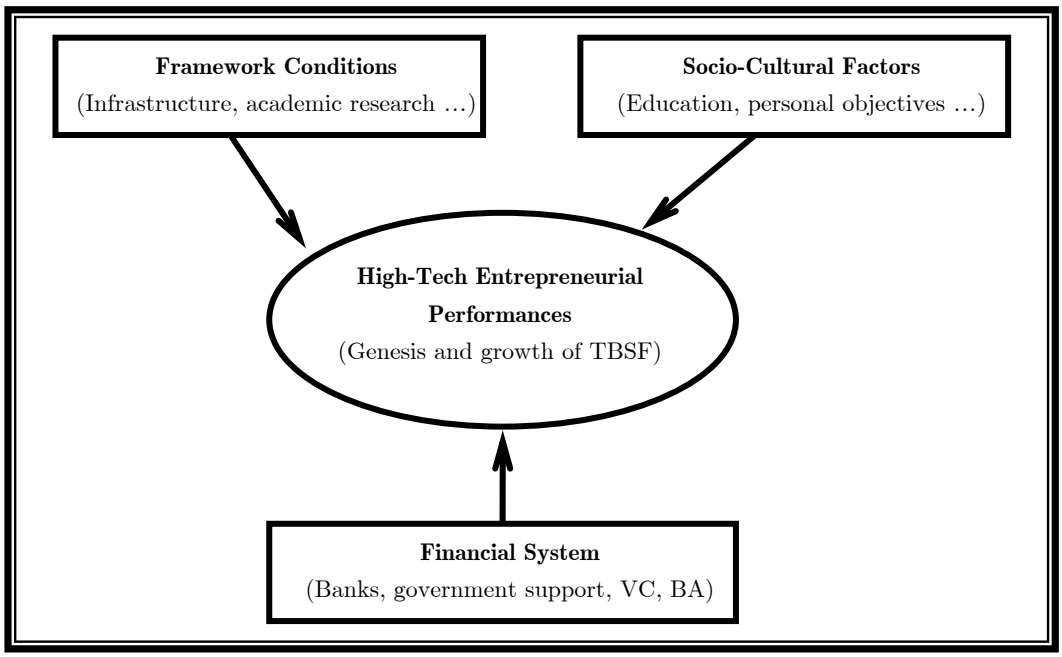
Now that we have succinctly presented the sources that inspired our survey questionnaire, let us present the construction of our questionnaire on Belgian TBSF.

[40] For further information on the Community Innovation Survey, see, for example, Archibugi *et al.* (1994), European Commission (2001), Capron and Cincera (2003), and European Commission (2004).

4.4.2. Our questionnaire

The creation and the performance of TBSF might be influenced by three main factors. The questionnaire was driven to get an accurate insight into these main factors (Figure 4.1).

Figure 4.1: Factors influencing the creation and performance of TBSF



These factors are the framework conditions (e.g. the quality and availability of infrastructures and communication channels, the level of academic and public research, ..), the financial system (availability of public funds, role of venture capitalists, availability of business angels,...) and the socio-cultural factors associated with the entrepreneurs and their environment (e.g. level of education, their parent's education, gender...).

A questionnaire survey is a frequently used method of collecting a wide range of information from a large number of respondents. Therefore, we created a questionnaire divided in 3 main parts, preceded by the respondent information (The questionnaire is available in Appendix 9.2, pages 179-196).

The respondents are asked to provide their full names, telephone and fax numbers, e-mail addresses and their current position in the company. The ideal respondent of the questionnaire was one of the founding entrepreneurs.

Part 1 is about the company information and consists of 5 main sections: company information, technology-based industry criteria, small size criteria, R&D information and patenting information. Some sections are further divided into sub-sections for clarity.

- Company information includes company mail address and postal code, location, VAT number, year of establishment, legal Form, start-up capital, and countries of business activity.

- Technology-based industry criteria includes 9 industries both manufacturing and services, listed by OECD (Hatzichronoglou, 1997) as "High-Technology" and "Medium-High-Technology" classification. The questionnaire also includes an additional "other" field for unlisted main sectors of activity.

- Small size criteria include questions to validate responses against the European Commission definition of a "small" firm (EC, 1996 and 2003). The validation is further divided into 2 sub-criteria: size and ownership. Size criteria include total number of employees, annual sales (turnover), and annual balance sheet totals (from year 2000 to 2002). Ownership criteria include number of start-up founders, number of owners with 25 percent or more ownership, and ownership by a parent company.

- R&D information includes 5 "yes or no" questions to collect information on respondents' R&D activities. Two additional questions collect broad percentage of R&D budget and commercialisation of R&D.

- Patenting information is constructed in two sub-sections. The first one concerns background information as regards patenting issues. Ten statements on cost issues, market conditions, secrecy, efficiency, and administration of patenting activities, are evaluated using a Likert scale[41]. The second part focuses on

[41] A Likert scale is an often used questionnaire format. It requests respondents to specify their level of agreement to each of a list of statements. It was named after Rensis Likert, who invented the scale in 1932. A typical question using a five-point Likert scale might make a statement, then ask the respondents to indicate whether they: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree. The results show an ordinal level of preference. Numbers have an inherent order or sequence but do not correspond to a precise mathematical value.

evaluating the patenting activity of TBSF: do they have patent(s), if it is the case, how many, and what is the broad percentage of commercialised patents?

The questions on R&D and patenting information are based on the survey of Peeters and van Pottelsberghe (2003), themselves based on CIS and other surveys on innovation. Questions have been adapted to the TBSF.

The Financing part (Part 2) is based on the existing work of the Bank of England (Brierley, 2001), the paper of Giudici and Paleari (2000) and on the Belgian study of Manigart and Struyft (1997). This part is subdivided in 5 sections:

- Current stage of development: This section includes two questions to establish the current stage of development (lifecycle) of the respondents' enterprises. The four stages of development include: "seed", "start-up", "early growth", and "expansion/development." The definition of each stage is included in the questionnaire, in brief footnotes.

- The matrix of sources of funds lists ten sources of funds across four stages of development. The nine sources plus "other" are listed in order to collect information from "internal" and "external" sources of finance. Internal sources include: personal, family and friends' funds, and retained earnings. External sources include: commercial bank loans, government subsidies of all kind, non-financial institutional funds, other debt-finance, business angel funds, venture capital funds, and other equity-finance. The respondents are asked to select their sources of funds for each stage by filling in the matching box.

- Bank financing information is divided into two sub-sections: bank financing Likert scale and banking activity. Bank Likert scale aims to detail respondents' perception about the bank financing of TBSF with a 12-statement scale. The banking activity sub-section has two "yes or no" questions and collects information with respect to the timing, name, and amount of bank financing.

- VC financing information is also divided into two sub-sections: VC financing Likert scale and VC financing activity. The 14-statement scale is used to detail the perceptions of respondents as regards to VC financing in Belgium. The second section has two aims. The first is to detail the timing, name, amount, and

government scheme information of VC financing source(s). The second is to collect information using seven "yes or no" questions about the senior management composition and future alliance plans.

- Business Angels (BA) financing information is also divided into two sub-sections: BA financing Likert scale and BA financing activity. In parallel with the venture capital financing information, the 14-statement scale permits to detail the perceptions of respondents as regards to BA financing in Belgium. The second section has two aims. The first is to detail the timing, name, amount, and government scheme information of BA financing source(s). The second is to collect information using five "yes or no" questions about the senior management composition and future alliance plans.

Part 3 on entrepreneurs' socio-cultural background and framework conditions is requested to be completed by at least one of the founding members or entrepreneurs[42]. It is constructed in four main sections. This part is based on papers from the empirical literature on firms' development.

- The first section on entrepreneur profile includes 21 questions based on a combination of "yes or no", fill-in the blanks, and fill-in the matching box(es). It is further divided into five sub-sections for clarity reasons: demographics, genesis of TBSF, educational background, family background, and previous work experience.

  - The demographic information includes age, gender, marital status and permanent residence (location).
  - The genesis of TBSF identifies four options to define the establishment: "start-up", "corporate spin-off", "university spin-off", and "other". The three definitions ("start-up", "corporate spin-off", and "university spin-off") are explained briefly in the questionnaire footnotes. Three additional questions are used to establish the genesis of the idea, duration and association of founders.

[42] Several copies of part 3 of the survey were sent in order to get the answer from each founder. However we only received the answer from the founder who also answered the rest of the questionnaire.

- The educational background sub-section gathers information about the founders' latest academic degree, field of study, name of institution, and any entrepreneurial-related courses attended.
- The family background section collects information about the founders' mothers and fathers' education background and employment.
- The previous work experience section has five questions to outline the work experience of entrepreneurs detailing duration, field of activity, last position held, and number of staff supervised.

- The entrepreneurial opportunities (Part 3, section 2) in Belgium is a section constructed around 24-statements measured with a Likert scale to gauge the respondents' perception of Belgium, with regards to the availability and accessibility of entrepreneurial opportunities. This section is grouped into five sub-sections: physical infrastructure, commercial and professional infrastructure, social and cultural norms, national research and technology development system, and government policies and programs.

- In the physical infrastructure sub-section, respondents are asked to rate availability and accessibility to Belgian physical infrastructure such as transportation networks, utilities, and communication networks.
- The commercial and professional infrastructure refers to all commercial and professional parties such as business consultants, analysts, lawyers, and supplies available to support new and growing TBSF. The respondents in this section are asked to rate availability of and access to such services.
- The social and cultural norms sub-section deals with questions concerning the social welfare system, taxing, and multi-lingual culture of Belgium for starting up or developing a young TBSF.
- The national research and technology development system subsection refers to the extent to which national research and development will lead to new commercial opportunities and whether or not these are available for new or growing firms. Respondents in this section are asked to rate availability and accessibility of the main actors involved in technology transfer including technology science parks, incubators, science labs, Intellectual Property Rights (IPR) administration, university-industry

networking, science and technology graduates, industry R&D, and networks among industries.

- The government policies and programs subsection highlights questions dealing with the availability and accessibility of government policies and programs that support R&D. It furthermore asks questions to rate the administration of the available programs.

- The entrepreneurship motives section is a 7-statement Likert scale constructed to better understand the motivations (realization of an innovative idea, personal challenge, money, activity, risk, experience) for starting up a new TBSF.

- The entrepreneur objectives outlook section is a 9-statement Likert scale. The statements include later-stage lifecycle objectives regarding improvement of existing product/services/processes, development of additional new products/services/processes, change or improvement of organization structure, change or improvement of management information systems, train/educate workforce, and eliminate brain drain from workforce.

In Belgium, we have different national languages. In order to minimize the bias related to the use of one or another language, the questionnaire has been written in three languages: French, Dutch and English (English is not an official language for Belgium but it is the international language for business)[43].

4.5. The TBSF survey methodology

Good questionnaire set up is very important in order to attain the objective of the survey. Inappropriate questions, inappropriate questionnaire format, unnecessary length of a questionnaire can make the survey useless. It seems that a useful method for checking a questionnaire for problems is to pre-test it. Therefore, our survey was developed in 3 stages. Comments from the pilot testing phase were used to prepare the interviews of the second phase. Finally, the questionnaire was mailed to the population of TBSF in Belgium.

[43] The three questionnaires are available in the Appendix 9.2, page 179.

4.5.1. Pilot testing of questionnaire

As explained, in order to improve the quality of the questionnaire we conducted three trial interviews with entrepreneurs with whom we had previous contacts. Each session lasted between 1 and 1.5 hours. These were companies operating in biotechnology, computers and office machinery, and electronics and telecommunications industries. The results of these initial interviews were not included in the final study. The questionnaire form was corrected following the pilot interviews and corrected to improve its clarity. The major change concerns the length of the questionnaire which has been reduced. Moreover, some questions have been rephrased for clarity purpose. After these corrections, revised questionnaires were sent to the identified Belgian population of TBSF (607 companies).

4.5.2. Interviews

We selected the companies and sent 35 personalized letters in the region language (Dutch or French and always an English one) to the contact person. The letters briefly explained the purpose for the study and asked the participant's assistance for cooperation, with full assurance of confidentiality. We mailed the letters in the first week of November 2002 and they were followed up by courtesy calls after five to ten working days.

A total of 28 (80 percent response rate) companies accepted to participate in the study and interviews were conducted in the months of November and December 2002. We used the revised questionnaire and supervised the respondents in completing the questionnaires by themselves. The completion of the questionnaires lasted 10-25 minutes. Further analysis of interview information based on technology, size criteria and complete availability of the responses showed that 3 interviews out of 28 needed to be excluded resulting in a total of 25 interviews for the study (71.5 percent response rate).

4.5.3. Mailing

We mailed 572 letters in the appropriate language (Dutch or French, and always an English version), based on the mail address of the enterprise. Both French and Dutch versions are included for the Brussels-Capital region to reflect the

bilingual nature of the region. Again, the cover letters briefly explained the reasons for the study and asked the participants' assistance for cooperation with full assurance of confidentiality. 308 of these letters were mailed directly to the contact person with full name and position details. The remaining letters (264) were addressed to the attention of the General Manager/Managing Director of the company. We mailed the letters in two batches of similar size. The first batch was mailed in mid-January 2003 and the second batch was mailed 15 days later. We e-mailed courtesy reminders to non-responding companies 15 days later. The number of usage of fax-message, telephone, and mail reminders was not important.

By January-March 2003 we received a total of 86 responses (15 percent). After entering those into TBSF database and validating based on industry, size, age, and completeness we eliminated 8 empty responses. As a result, we managed to collect 78 (13.6 percent response rate) valid mail questionnaires to be analyzed in this study. These questionnaires were added to those from the 25 personal interviews.

Table 4.3: Response rates according to the type of answer

	# Surveyed firms	**# Responding firms**	**Response rate**
Type of answer			
Interview	35	25	71.5%
Mailing	572	78	13.8%
Total	**607**	**103**	**17.0%**

Sources: TBSF database, own calculation.

The total number of valuable responses was 103. The previous table (Table 4.3) presents the different response rates. By the end of 2003, we had completed the encoding of the data and we have implemented the financial data with the database of Graydon.

In chapter 6, we will test if the mode of answering did not cause a bias.

4.6. Concluding remarks

Entrepreneurial activity contributes to economic growth. A number of issues remain to be tackled in order to feed a culture of entrepreneurship. The core of these issues concentrates mainly on entrepreneurs themselves and the environment they operate in.

Using original survey data, this chapter details the data and methodology employed to examine the entrepreneurs and sources of finance for 103 small Belgian technology-based firms established between 1985 and 2002.

In line with other countries, such as Germany, it will be very interesting to create a database on TBSF that will systematically include data on the three main factors of development: the framework conditions (including the R&D activities of firms), the financing and the entrepreneur(s)/founder(s).

Entrepreneurial activity particularly in high-growth technology-intensive industries could be more developed in Belgium. The primary objectives of our forthcoming research are to better understand the key socio-economic determinants of entrepreneurial activity and the extent to which technology-based small firms face important constraints in raising financial resources in Belgium.

CHAPTER 5:

TECHNOLOGY-BASED SMALL FIRMS IN BELGIUM – STATISTICAL EVIDENCE

5.1. Introduction

In chapter 4 we have presented the methodology of the original survey carried out in Belgium on Technology-Based Small Firms (TBSF). After developing a database including 607 companies that matched the criteria of small size and high-tech industry in 2002, we received 103 questionnaires fully filled-in, which represents a response rate of 17 percent. Answers were received either through interviews (25) or by mail (78)[44]. Therefore, we are able to gather a wealth of new and original information.

The objective of this chapter is to present, relying on our database, statistical evidence on Belgian high-tech companies and their entrepreneurs/founders. This chapter gives an insight on the TBSF in Belgium. Moreover it introduces the econometric study presented in chapter 6 and describes some of the variables used in our empirical analysis.

In the following sections evidence is provided concerning companies' and entrepreneurs' characteristics, technology transfer and innovation, and financing. Indeed, the focus will be on the following questions: Who are the Belgian

[44] In the next chapter, we will test econometrically the possible bias induced by the type of answer.

entrepreneurs? What motivates them? What are the main opportunities for setting up a business in Belgium? In other words, this chapter has five main objectives:

- To describe the characteristics of the sample of high-tech companies.
- To investigate technological transfers and innovation activities.
- To study the social and educational culture underlying entrepreneurship.
- To analyse entrepreneurs' opinions on physical, social, commercial and professional infrastructures, with the aim of better understanding TBSF entrepreneurship.
- To examine the reasons and perceptions behind entrepreneurs' activity.

5.2. Performance

The first table of this chapter presents the performances of the companies in the sample in terms of employment and results after tax. These two indicators are the most studied in this literature[45].

Table 5.1: Employment and results after taxes for the period 1998-2003 (or the longest available period)

	Employment					
	Stop activities	Decrease	Constance	Increase	Not available	**Total**
Results after tax						
Stop activities	11	0	0	0	0	11
Decrease	0	4	5	31	1	41
Increase	0	8	5	25	1	39
Not available	0	0	0	0	12	12
Total	**11**	**12**	**10**	**56**	**14**	**103**

Sources: Graydon, Belfirst and TBSF database, own calculation.

Out of the 103 small high-tech companies of our sample, only 92 companies were still in activity in 2003 (Table 5.1). In 56 cases, we observe a growth in employment between 1998 and 2003. 22 companies have had a constant or decreasing employment during that period. As to the results net of taxes, 39 companies enjoyed a growth and

[45] Moreover, as seen in the introduction of this thesis, the employment is a big challenge for governments. This explains why we will focus on this variable in the next chapter.

41 companies underwent a loss between 1998 and 2003. It should however be kept in mind that no information is available on the growth of employment and on the profits (net of taxes) for 14 and 12 TBSF, respectively.

In our sample, around 10 percent of the companies stopped their activities during the period 1998-2003. This percentage seems to be realistic as we know that the National Institute of Statistics (INS, Ecodata) lists a percentage of approximately 7 percent of high-tech and medium-high-tech company closures for the year 2002. As this percentage only refers to 2002, and as we cover a larger period but only for small companies, we may accept the level of 10 percent as a reasonable approximation of the population data. Therefore, in terms of number of companies that stop their activity, we may argue that our sample is a good representation of the national population of small technology-based firms.

The most instructive observation derived from Table 5.1 is that employment and results net of tax do not systematically follow the same trend. Indeed, employment remained at least constant in 36 out of the 41 companies enduring losses. Only 25 TBSF, out of the 92 still in activity in 2003, enjoyed a growth in both employment and results net of taxes between 1998 and 2003.

The discrepancy between employment and financial performance validates Janssen (2004) findings that these two variables are not accounted for by the same factors. Indeed, in the literature, authors use many different indicators as determinants of companies' performance. As explained in the previous chapter, Janssen investigates on whether these indicators are interchangeable. He shows that employment and sales are not identical approximations of the concept of company development because they are determined by different factors. In order not to make confusion between all possible performance indicators, in the next chapter we will only focus on the employment variable.

5.3. Firm characteristics

All companies of our sample have been founded between 1985 and 2002. Table 5.2 breaks down the number of companies by age and industry, at the time of the survey.

The great majority of companies are less than five years old. In 2002, only 7 companies have more than 15 years (between 16 and 18 years) and 65 companies have less than 5 years. The four high-tech sectors are well represented in our sample: 13.6 percent of companies belong to the sector of aerospace and instruments, 27.2 percent to the sector of computer, 26.2 percent to the electronics sector, and 22.3 percent to the pharmaceutical industry. The remaining 10.8 percent of surveyed companies belong to other medium-high-tech sectors.

Table 5.2: Age of companies by industry in 2002

	#	Age of companies in years			
		Between 1 and 5	Between 5 and 10	Between 11 and 15	More than 15
Industry					
Aerospace and Instruments	14	11	1	0	2
Computer	28	17	9	2	0
Electronic	27	17	5	4	1
Pharmaceutical Industry	23	15	1	4	3
Medium-high-tech Industry	11	5	1	4	1
Total	**103**	**65**	**17**	**14**	**7**

Sources: TBSF database, own calculation.

Mayer (2002) summarizes the development of high-technology firms in four stages. The first is the "seed stage", when a concept of product has still to be proven and developed. The second is the "start-up stage" when products are developed and initial marketing takes place. The third is the "early growth stage development" when the firm is expanding and producing but it may well remain unprofitable. Finally, the "Expansion/Development stage" includes the expansion of an established company that requires increasing its production capacity, marketing, and sales to grow before a possible initial public offering (IPO).

Table 5.3 breaks down the age of the enterprise by the current stage of development. As it would be logical to expect, it shows that the stage of development is a positive function of the age of the company. Older companies are in a more advanced stage of development. Indeed, not a single seed company has more than 5 years, no company in the start-up stage has more than 10 years, and finally no early-stage company has more than 15 years.

Table 5.3: Age and current stage (number of observations as of 2002)

	#	Claimed Current Stage			
		Seed	Start-up	Early Growth	Development
Age (years)					
Between 1 and 5	65	4	13	32	16
Between 5 and 10	17	0	1	9	7
Between 11 and 15	14	0	0	3	11
More than 15	7	0	0	0	7
Total	**103**	**4**	**14**	**44**	**41**

Sources: TBSF database, own calculation.

According to Grilo and Thurik (2004), empirical evidence documented the shift in economic activity that was taking place away from large firms towards small, predominantly young companies. Size of the company as a factor of growth is a well-developed field of research (Agarwal and Audretsch, 1998; Harada, 2003; Colombo and Grilli, 2005a). In the previous chapter we have seen that the number of employees is one possible indicator of growth but others variables exist. In the questionnaire, we approach the company size with three concepts because of the definition of small companies[46]. Table 5.4 illustrates TBSF size characteristics in 2002 by industry.

The number of employees working in the surveyed companies in 2002 is the first key indicator. More than half the companies belonging to the sectors of aerospace and instruments, computer, and electronics employ less than 10 persons. In the aerospace and instruments sector, there are even more than 85 percent of companies employing less than 10 persons. The majority of companies belonging to other medium-high-tech sectors in our sample have between 11 and 25 employees. Overall, 63 percent of the companies on which information is available employ less than 10 persons. In spite of the above-mentioned definition, we decided to keep 5 companies with more than 50 employees because these exceed the limit in 2002 or because these are quite similar to TBSF for all other variables.

[46] For more details on the definition see page 80, in chapter 4.

Table 5.4: TBSF size characteristics by industry in 2002

	#	Number of employees				
		Less than 10	11-25	26-50	More than 50	Not available
Industry						
Aerospace and Instruments	14	12	1	1	0	0
Computer	28	17	3	2	1	5
Electronic	27	15	6	1	1	4
Pharmaceutical Industry	23	9	3	4	3	4
Medium-high-tech Industry	11	3	5	2	0	1
Total	**103**	**56**	**18**	**10**	**5**	**14**

	#	Turnover					
		Less than 1.000.000	1.000.000-3.000.000	3.000.000-5.000.000	5.000.000-7.000.000	More than 7.000.000	Not available
Industry							
Aerospace and Instruments	14	3	0	0	0	0	11
Computer	28	8	2	1	1	1	15
Electronic	27	5	3	1	2	1	15
Pharmaceutical Industry	23	4	2	0	1	2	14
Medium-high-tech Industry	11	4	1	1	0	1	4
Total	**103**	**24**	**8**	**3**	**4**	**5**	**59**

	#	Balance Sheet				
		Less than 1.000.000	1.000.000-3.000.000	3.000.000-5.000.000	More than 5.000.000	Not available
Industry						
Aerospace and Instruments	14	11	2	1	0	0
Computer	28	18	2	2	1	5
Electronic	27	14	7	1	1	4
Pharmaceutical Industry	23	5	3	2	9	4
Medium-high-tech Industry	11	4	3	3	1	0
Total	**103**	**52**	**17**	**9**	**12**	**13**

Sources: Graydon, Belfirst and TBSF database, own calculation.

The second indicator of size characteristic is the turnover (Table 5.4). Since the sales turnover is optional information, in the shortened diagram of the accounts that these companies submit to the National Bank of Belgium, this variable is not available for the whole sample in the table. More than half of the sample does not reveal this information. The other companies have an average turnover of less than € 1 million.

The last indicator of size that we will adopt is the total balance sheet[47] (Table 5.4). 52 companies have a total balance sheet of less than € 1 million. This information is not available for 13 companies only.

5.4. Technology transfer, innovation and intellectual property right

R&D is an important driver of development for innovative enterprises (i.e. Engel and Fire, 2000). Moreover, evidence regarding the effects of technological spillovers on productivity has also been found. Cincera (2005a) confirms the higher social returns of R&D activities as compared to the private ones. Therefore, this section is very important and will provide evidence concerning the importance of technology transfers, patents to Belgian TBSF and the role of universities for these companies.

5.4.1. Technology transfer before the creation

Licht and Nerlinger (1998) argue that, in the context of high-tech sectors, the founder of technology-based small firms may receive transfers of technology and entrepreneurial know-how from his/her previous employer, which may be an industrial firm, a university or a research institute.

The survey questionnaire identifies several possible origins of the innovative idea that led to the creation of a company. Since these are not mutually exclusive, an entrepreneur can select more than one option (for example, university research as well as foreign technology). Answers are summarized and broken down by type of company in Table 5.5.

It shows that our sample of 103 companies is mainly made of start-ups (55). The second most represented category is the academic spin-offs (41), and the least represented companies are corporate spin-offs (6). A Start-up company refers to a fully independent new company. A Spin-off company is an incorporated commercial entity that derives a significant portion of its commercial activities from the application or use of a technology and/or know-how developed by or during a research program.

[47] Balance Sheet is a company's financial statement. It reports the company's assets, liabilities and net worth at a specific time.

Depending on whether this research programs are located within a firm or within a university, they are called corporate spin-offs or academic / university spin-offs[48]. In this dissertation we will use the terms academic spin-off as equivalent to university spin-off.

Table 5.5: Type of company and origin of the innovative idea

	Type of company				**Total of the row**
	Start-up	University Spin-off	Corporate Spin-off	Not available	
#	**55**	**41**	**6**	**1**	**103**
Origin of the idea					
Independent	25	10	3	0	**38**
Business experience	31	3	3	0	**37**
Technology used abroad	4	0	1	0	**5**
University research	2	30	0	0	**32**
Business research	1	3	2	0	**6**
Not available	0	1	0	1	**2**

Sources: TBSF database, own calculation.

Only 30 founders of a university spin-off, out of the 41 of our sample, explain the creation of their company by some research carried out in a university, and 10 affirm the idea was their own personal one. Out of the 6 corporate spin-offs, 2 were created on the basis of private research. Out of the 55 start-ups, 31 find their origin in, among other things, the business experience of their founder. 25 founders of start-ups also cite a personal idea at the origin of the creation of their company. These results confirm the founding of Licht and Nerlinger (1998). More than 70 technology-based small firms' entrepreneurs state that their idea comes from transfer of technology and entrepreneurial know-how from an industrial firm, university or research institute.

[48] Behind the term university spin-off, there are different realities. For more details, see Pirnay, Surlemont and Nlemvo (2003).

5.4.2. Research activities and technology transfers after establishment of the companies

We asked the entrepreneurs belonging to our sample whether they perform R&D activities in their company. Table 5.6 outlines the summary findings on R&D activity.

A very large number (86 percent) of these TBSF are active in research activities. This search for new knowledge is not performed only in-house, as more than 50 percent of the firms are involved in active cooperation with a higher education institution. 26 percent of the firms collaborate with Belgian public research centres. Half of the TBSF received public support for their R&D activities, whereas only 14 percent benefited from tax deductions for these activities.

R&D seems to be very important for firms' long-term sustainability, as they allocate on average 29 percent of their budget to R&D expenses and exploit commercially more than 40 percent of their innovation output.

Table 5.6: TBSF R&D activities

Section A		#	
	#	**Yes**	**No**
Does your firm perform Research & Development (R&D) activities?	103	89	14
Does your firm collaborate in R&D with Belgian higher education institutes?	103	52	51
Does your firm collaborate in R&D with Belgian public research centres?	103	27	76
Does your firm take advantage of government/public R&D subsidies?	103	52	51
Does your firm benefit from R&D tax credit facility?	103	14	89
Section B	#	**Average**	
Percentage of annual budget spent for R&D	83	29 %	
Part of R&D projects that are exploited commercially through own production	76	43 %	

Sources: TBSF database, own calculation.

Some conclusions on the role of universities in technology transfers before and after the establishment of a company can be drawn. According to Capron and Cincera (2003), at the European level, universities are not the only source of information that firms use to back their innovation process. Nevertheless information from universities appears to be more important in Belgium as compared to the European average. Indeed, the TBSF sample shows the importance of this relationship between high-tech companies and universities. Table 5.5 shows that 32 companies out of the sample have

been created on the basis of university research. Moreover, Table 5.6 outlines that more than 50 percent of the firms active in R&D are involved in active cooperation with a higher education institution. Therefore in the following chapter, we will try to test for the role of universities on the performance of Belgian TBSF in terms of employment.

5.4.3. Patent

Patents are a measure of protection conferred to the creator of an invention and, in so doing, add value to intangible assets of a young and small innovative company. They further provide protection and possible sources of income due to future royalty fees. We asked whether Belgian entrepreneurs have filed a patent since their establishment. The result depends largely on the industry in which the company is included (Table 5.7 section A). More than 60 percent of the TBSF in the pharmaceutical and Instruments sectors have filed at least one patent. This ratio is much lower in the sectors of aerospace, computer and electronics, where the patent system does not seem to guarantee an effective protection of intellectual property.

Section B in Table 5.7 summarises the findings on the opened questions related to the issue of patents. The patenting TBSF seem to make an active use of their patent portfolios, as about 60 percent of their patented inventions are exploited commercially and 11 percent are licensed to third parties.

In order to have a better understanding of the entrepreneurs' perception on the patenting process, an 11-statements Likert scale is presented. The results of this scale are shown in section C of Table 5.7. We find that the cost of patenting, limited financial and human resources, lack of in-house competence, lack of secrecy, imitation, low value creation because of no development, and administration costs represent the negative aspects of the patenting process. More than 55 percent of the entrepreneurs find that the level of patenting fees and cost of protection are high. On the other hand, more than 40 percent of firms find that the statement on the lack of information or know-how on the patenting process is false.

Table 5.7: TBSF patenting activities

Section A		**Percentage (%)**	
Have you filed a patent?	**#**	**No**	**Yes**
Industry			
Aerospace and Instruments	14	50	50
Computer	28	96	4
Electronic	27	70	30
Pharmaceutical Industry	23	35	65
Medium-high-tech Industry	11	82	18
Total	**103**	**68**	**32**

Section B	**#**	**Average**
Broad percentage of its patent portfolio actively used by your firm	32	60 %
Total number of patents used in your firm's patents portfolio in the first year	30	1.1
Total number of patents used in your firm's patents portfolio in 2001	29	1.4
Broad percentage of patents granted that are licensed commercially	31	11 %

Section C

"We do not patent our inventions systematically because:"	**Percentage (%)**		
	Agree	**Disagree**	**Neutral**
Cost of fees is high	55	12	33
Cost of protection is high	67	7	26
Protection not efficient due to the lack of confidence in the system	30	28	43
Secrecy is more efficient	41	20	38
Market lead is more efficient	45	14	41
Product life cycle is short	31	31	38
Invention disclosure is risky	35	28	37
Inability to prevent other firms from copying the technology	45	18	37
No information or know-how on the patenting process	27	46	28
Administration is slow	32	28	40

Sources: TBSF database, own calculation.

Just as large firms and firms in high-tech sectors, firms with permanent R&D activities have a higher probability to engage in patenting activities (Cincera, 2005b). Table 5.8 breaks down the type of R&D activities by the patenting activity of the firm. The different types of R&D collaborations are not mutually exclusive. In other words, we find that companies could carry out private research in collaboration with Belgian higher education institutes and/or with Belgian public research centres.

Table 5.8: Patent(s) field according to type of research activities

	Have filed at least one patent		**Total of the row**
	No	Yes	
#	**70**	**33**	**103**
R&D			
Research & Development (R&D) activities	57	32	89
R&D with Belgian higher education institutes	25	27	52
R&D with Belgian public research centres	11	16	27

Sources: TBSF database, own calculation.

Table 5.8 shows that 33 companies have filed at least one patent since their establishment. Among these 33 Belgian TBSF, 32 were active in R&D, 27 collaborated with universities and 16 collaborated with public research centres. 70 companies of our sample did not file any patent and, among these 70 companies, 25 carried out research with universities, 11 with private research centres and 13 of them are not active in R&D at all.

5.5. The financing issue

5.5.1. Sources of financing

Berger and Udell (1998) argue that, given their limited operating history, start-ups are, in term of information, the most opaque firms in the economy. Lack of financial resources is one of the major problems that these start-ups face. Gompers and Lerner (2001a) further argue that innovation fails to create value when firms cannot attract the resources required to sustain their development and their rapid growth.

In addition to a number of studies investigating the financing of small entrepreneurial firms (Laranja, 1995; Fluck *et al.*, 1998; APCE, 2000; Giudici and Paleari, 2000; Brierley, 2001; Cassar 2004), Manigart and Struyf (1997) study the financing of 18 high-technology Belgian start-ups. They conclude that the most important sources of financing, at the start-up stage, are the entrepreneurs themselves and the banks. Their findings suggest that the role of government is not significant.

Consistent with their findings we find that internal finance is critical for entrepreneurs to start-up new technology-based firms (Table 5.9). The founders' personal funds are the primary source of finance in term of type of funds (not in term of fund amount). We find that more than 80 percent of entrepreneurs use it. The "debt-finance" funds, in the form of commercial bank loans, are the secondary sources of finance and constitute a bigger portion of total external finance. 38 percent of the firms have been recipients of Venture Capital (VC) funds and 23 percent benefited from business angel funds[49]. On the whole, 84 percent of the companies use internal funds and 69 also resort to external funds.

Table 5.9: Sources of finance (in percentage of the industry)

	#	**Sources of finance**				
		Internal Funds		External Funds		
		Personal funds	Family and friends funds	Commercial bank loans	Business Angel funds	Venture Capital funds
Industry						
Aerospace and Instruments	14	100.00	14.29	57.14	0.00	21.43
Computer	28	85.71	39.29	32.14	25.00	32.14
Electronic	27	88.89	51.85	44.44	33.33	40.74
Pharmaceutical Industry	23	73.91	26.09	39.13	34.78	65.22
Medium-high-tech Industry	11	72.73	36.36	54.55	0.00	9.09
Total	**103**	**84.47**	**35.92**	**42.72**	**23.30**	**37.86**
Total	**103**	**84.47**		**68.93**		

Sources: TBSF database, own calculation.

These results tend to show that, even though the common idea that banks do not lend money to highly risky projects, the reality is different. Truly, the role of the risky investor is more appropriate to venture capitalists but commercial banks also are a key source of funds. According to Colombo and Grilli (2005a), the difference between bank debt-financed firms and external private equity-financed firms is the start-up size. Indeed, bank debt-financed firms are no larger than firms created relying exclusively on founders' personal savings, while firms that received external private equity financing have a larger start-up size.

[49] Recall that this does not mean that the fund amount proportion is the same.

Table 5.10 outlines the average amounts invested by different sources of finance. This table was presented in Bozkaya *et al.* (2003) based on the same survey. However, it must be noted that the answering rate of this part of the questionnaire is different than for Table 5.9. Hence, a direct comparison with the previous table is not appropriate.

Table 5.10: average amount of funds provided (Amount in KEURO)

Sources of Funds:	#	Min	Max	Median	Mean	Std. Dev.
Personal Funds of Founders	75	4.0	1,250.0	45.9	124.4	232.9
Family and Friends Funds	10	20.0	1,000.0	27.5	167.3	304.1
Commercial Bank Loans	39	5.0	5,000.0	100.0	569.4	1,117.9
Business Angel Funds – First Round	39	25	5,000.0	200.0	478.8	1,005.6
Business Angel Funds – Second Round	9	20.2	3,700.0	150.0	760.1	1,327.5
Venture Capital Funds – First Round	34	12.0	9,000.0	193.8	919.5	1,846.9
Venture Capital Funds – Second Round	15	23.8	25,500.0	385.0	3,105.0	6,936.7

Sources: Bozkaya, Romain and van Pottelsberghe, (2003).

Venture capitalists provide the highest average amount of funds (919.5 KEURO) to TBSF. Commercial banks follow this with an average of 569.4 KEURO. Business angels in our sample invest an average of 200.0 KEURO. The entrepreneurs themselves invest an average of 124.4 KEURO from their own personal savings.

5.5.2. VC from the Belgian entrepreneurs' point of view

We asked entrepreneurs to respond to statements regarding VC financing difficulties faced by their high-tech start-ups. Table 5.11 outlines the scores of 97 Belgian TBSF entrepreneurs regarding venture capital financing. A total of 38 percent of our respondents used venture capital financing at one stage of their development.

The reliance on VC funding is hindered by different factors (see Table 5.11). For more than 55 percent of the TBSF, VC is difficult to use because of the unwillingness of VC firms to provide small amounts of capital, their lack of interest in early stage investments, their expectation of high rates of return and of quick exits. As it seems to be difficult to have access to appropriate VC funds, public actions could be defined as to improve the accessibility and appropriability of VC funds. The second section of the

concluding chapter proposes some actions to stimulate the supply-side and the demand-side of VC.

Table 5.11: VC financing for Belgian entrepreneurs

"Venture Capital (VC) financing for a high-tech start-up has difficulties because of"

(n=97)	Percentages (%)		
	Agree	**Disagree**	**Neutral**
Lack of VC firms' interest in early stage investments	55	16	29
Unwillingness of VC firms to provide small amounts of capital	58	15	27
Lack of understanding of technology by many VC firms	34	26	40
Lack of our firm's registered intangible assets (i.e. patents)	30	26	44
Poor quality of our Business Plan and presentation to raise VC funds	13	46	40
Lack of our entrepreneurial/managerial skills	24	37	39
Our concerns over "loss of control" in the company	40	31	29
VC expectations of high rates of return	59	13	28
Due Diligence difficulties faced by VC	27	22	51
VC firms' expectations of quick exits	61	10	29
Lack of our market information on Belgian VC activities	31	31	38
Lack of Belgian VC executives with specific knowledge and skills	46	14	39
Limited public policies to encourage equity participation	54	7	39
Administration and bureaucracy of government-supported programs	47	8	44

Sources: TBSF database, own calculation.

Table 5.12 outlines the venture capital-related summary of our findings.

Table 5.12: Venture capital financing

Panel A: Summary Findings

		Percentages (%)	
	#	**Yes**	**No**
Did You Raise any VC Financing at any Stage?	103	38	62
Did You Participate in any Government-supported VC Programs?	39	5	95
Did You Employ a Full-time Finance Manager During VC Negotiations?	39	36	64
Did You Employ a Full-time Marketing Manager During VC Negotiations?	39	23	77
Did You Get Involved with any Incubator Before or During VC Negotiations?	39	38	62
Did You Use any Management Consultancy Services During VC Negotiations?	39	46	54
Does Any Participating VC Firm Own more than 25% of Your Enterprise?	39	36	64
Do You Eventually Plan to Participate in Management-Buy-Outs (MBO)?	39	49	51
Do You Eventually Plan to Participate in Initial-Public-Offering (IPO)?	39	67	33

Sources: TBSF database, own calculation.

5.6. Entrepreneurs' profile

This section focuses on the characteristics of entrepreneurs. There is a large literature on entrepreneurship with a number of studies investigating the perspective of finance, management, sociology, psychology, and education[50]. This section aims to analyse, using our survey data on small technology-based Belgian firms, the impact exerted by the social and the educational culture on entrepreneurship. To the best of our knowledge, there is very limited literature specifically focusing on the Belgian issue, except for Manigart and Struyf (1997) who studied the financing of 18 entrepreneurial Belgian firms.

The profile of each entrepreneur is assessed by several questions recording age, marital statute, residence, education, professional experience, and other characteristics. The majority of entrepreneurs are between 30 and 39 years old (Table 5.13). The age of the entrepreneurs has been studied in a number of works (for example: Cressy, 1996 and Harada, 2003). In addition to gender and age, marital status, degree or diploma, past work experience and parents' background (education and work experience) are other important factors shedding light on the genesis and development of TBSF (Markman and Baron, 2003; DeMartino and Barbato, 2003; Anderson and Miller, 2003; Aldrich and Cliff, 2003).

Table 5.13: Age of entrepreneurs

	#	Age				
		Less than 30 years	**30-39**	**40-49**	**50 years and more**	**Not available**
Industry						
Aerospace and Instruments	14	2	6	2	4	0
Computer	28	8	13	5	2	0
Electronic	27	2	14	7	2	2
Pharmaceutical Industry	23	1	5	7	9	1
Medium-high-tech Industry	11	0	2	5	4	0
Total	**103**	**13**	**40**	**26**	**21**	**3**

Sources: TBSF database, own calculation.

[50] For an interesting study on entrepreneurship in Wallonia, see Cincera *et al.* (2006).

Human capital is also an important determinant of technology-based entrepreneurial activity. According to Engel and Fier (2000), the considerable importance of intellectual capital in universities can explain the regional concentration of high-tech start-ups.

In order to illustrate the human capital of Belgian high-tech entrepreneurs, we asked them to provide personal data on their age, gender, marital status, permanent residence, family, educational background, past work experience, and their parents' education. Indeed, according to Burton *et al.* (2002), entrepreneurs with advanced degrees establish firms with innovation strategies, but entrepreneurs with sales or finance experience are less likely to pursue an innovation strategy.

Table 5.14 shows that 80 percent of surveyed entrepreneurs/founders of TBSF have at least a university degree and 25 percent hold a Ph.D. According to Licht and Nerlinger (1998), the probability of a cooperative contact with a university is higher when the entrepreneur of the technology-based firm has obtained a Ph.D. Table 5.15 controls for this statement.

Table 5.14: Education level of entrepreneurs

	#	Highest Degree/Diploma obtained			
		High School or Higher education less than 3 years	**University degree or Master**	**Ph.D. or Post-Doctorate**	**Not available**
Industry					
Aerospace and Instruments	14	1	8	5	0
Computer	28	7	21	0	0
Electronic	27	4	16	5	2
Pharmaceutical Industry	23	3	6	14	0
Medium-high-tech Industry	11	3	6	2	0
Total	**103**	**18**	**57**	**26**	**2**

Sources: TBSF database, own calculation.

Table 5.15 shows that, in term of research activities, 88 percent of the entrepreneurs (23 entrepreneurs on 26) holding a Ph.D. or a post-doctorate collaborate with Belgian higher education institutes. Moreover, more than 90 percent of these entrepreneurs are working in a university spin-off. However, the causality issue limits the validity of this

conclusion. We do not know whether the probability of cooperation between a university and a high-tech company is higher if the entrepreneur of the technology-based firm has obtained a Ph.D. or whether the opposite is rather true.

Table 5.15: Contact with university according to diploma obtained

	#	Highest Degree/Diploma obtained				
		High School or Higher education less than 3 years	**University degree or Master**	**Ph.D.**	**Post-Doctorate**	**Not available**
R&D with Belgian higher education institutes						
No	51	13	35	3	0	0
Yes	52	5	22	15	8	2
Total	**103**	**18**	**57**	**18**	**8**	**2**
Type of company						
Start-up	55	13	41	1	0	0
University Spin-off	41	2	14	16	8	1
Corporate Spin-off	6	3	2	1	0	0
Not available	1	0	0	0	0	1
Total	**103**	**18**	**57**	**18**	**8**	**2**

Sources: TBSF database, own calculation.

5.7. Entrepreneurs' point of view

This section aims to study the impact of the physical, social, commercial and professional infrastructures on TBSF entrepreneurship, and to shed light on the perceptions of entrepreneurs and on the reason behind their choices.

A Likert scale was prepared to gather information to achieve these objectives.

What motivates Belgian high-tech entrepreneurs?

Herron and Robinson (1993) and Suzuki *et al.* (2002) identify several individual factors, such as personality, skills, values, background, and training, that might influence the decision to become an entrepreneur. The authors further suggest that

entrepreneurial motivations vary across geographical regions. For example, Japanese entrepreneurs were more society-oriented while *Silicon Valley* entrepreneurs were motivated by more individualistic factors such as personal achievement and accumulation of personal wealth.

As we are not aware of any study carried out on this subject, in Belgium, we approached the issue with an open mind to find out what motivates Belgian TBSF. In order to achieve our objective we construct 16 Likert scale questions on motives and objectives. Table 5.16 and Table 5.17 respectively outline the summary results.

Table 5.16: Motivation of founders/entrepreneurs

"I consider that my company is a high-tech firm and:" (Likert scale) in percentage			
	Agree	**Disagree**	**Neutral**
I perceive myself having entrepreneurial abilities	91	1	8
My main motivation to create my own company is:			
to develop an idea	88	7	6
to be my own boss	72	16	12
to earn more money	44	25	30
to find a professional activity	37	41	23
the attraction for the risk	32	37	31
Nice experience and I'm ready to do it again	77	5	18

Sources: TBSF database, own calculation.

More than 90 percent of the founders of the surveyed companies believe they have good entrepreneurial abilities (Table 5.16). Results show that most of them decided to start this challenge in order to develop their ideas and in order to depend on no one. They usually view their activity as a good experience, and they would be ready to start again.

Their main objective in the early years of their company is to improve existing products and/or services, rather than changing the organisational structure of their company or improving the skills of their company's workforce (Table 5.17).

Table 5.17: Objective of founders/entrepreneurs

"My objectives at Early Development Stage of my high-tech firm are:" (Likert scale) in percentage			
	Agree	**Disagree**	**Neutral**
Improve our existing products/services	79	6	15
Improve our existing processes	70	9	21
Develop additional new products	78	6	16
Develop additional new processes	67	5	28
Develop additional new services	75	5	21
Change/improve organisational structure	56	17	27
Change/improve management information systems	45	22	33
Train/educate workforce	46	20	34
Eliminate brain drain from our workforce	37	30	33

Sources: TBSF database, own calculation.

Which opportunities are available in Belgium?

The GEM report (De Clercq *et al.* 2002) results show that Belgian GEM respondents perceive favourably commercial and professional infrastructures while they find the government policy support, the low regulation and the taxation burden are unfavourable for entrepreneurial activities. The GEM study however fails to differentiate high-technology start-ups from other medium-low technology companies. In this survey, using scale statements, we approach TBSF entrepreneurs to better examine their perception and their satisfaction of the available infrastructures that would stimulate the genesis and the development of entrepreneurship. Table 5.18 represents the responses of TBSF entrepreneurs as detailed above.

The first five questions of this scale handle physical infrastructure. The following three questions are on the commercial and professional infrastructures. The following four questions focus on the social and cultural norms. The remaining 12 questions are about national research and technology development system, and government policies and programs.

Many scholars study the supporting infrastructure (for example: Zucker *et al.*, 1998; Feldman, 2001; Suzuki *et al.*, 2002)[51]. Table 5.18 shows the opinion of Belgian

[51] See previous chapter for details about this literature.

entrepreneurs on these issues. Entrepreneurial opportunities are especially improved by the following factors (factors underlined by more than half of the respondents): a developed communication network, multilingual and multicultural people, developed transportation networks, and the availability of commercial and professional networks. On the other hand, respondents disagreed firmly on the positive effects of the following factors (underlined by more than 60 percent of the respondents): the personal income tax system, the corporate tax system, and the administration of public department/agencies.

Table 5.18: Opportunities offered by Belgium

"I think Belgium offers entrepreneurial opportunities for high-tech start-ups because of:"

(Likert scale) in percentage

	Agree	**Disagree**	**Neutral**
Developed transportation networks	53	11	35
Developed utilities	48	15	37
Cost of utilities	28	24	49
Developed communication network	70	5	26
Cost of communications	26	20	54
Availability of commercial and professional networks	51	15	33
Cost of commercial and professional networks	23	18	59
Availability of specialized business analysts for high-tech development	33	25	42
Multilingual and multicultural people	75	9	16
Personal income tax system	7	73	20
Corporate tax system	8	65	28
Social security and welfare system	26	40	34
Administration of public departments/agencies	11	60	29
Government & public policies	20	48	32
Government/public funds available for Research & Development	44	34	22
Technology Regions/Science Parks	44	17	39
Administration of Intellectual Property Rights, patents	12	33	54
Cost of registration of Intellectual Property Rights, patents	10	34	55
Number of Science and Technology graduates	42	23	35
Transfers between universities/public labs and industries	43	14	43
Technology incubators	30	19	50
Networks among industries	24	23	53
Applied research at the higher education institutes	33	20	47
Research & Development at industry level	23	19	58

Sources: TBSF database, own calculation.

The following table (Table 5.19) resumes these findings.

* More than half of entrepreneurs highlight these factors as strengths in Belgium.

** More than half of entrepreneurs stay neutral about these factors. They find that these factors are neither opportunities nor weaknesses, in Belgium.

*** More than 60 percent of the entrepreneurs find that the first 3 factors of this column reduce the propensity to create companies, in Belgium. 48 percent of them regard the 4th factor as an obstacle.

Table 5.19: Opportunities offered by Belgium

Main strengths*	**To consider****	**Necessary urgent actions*****
multilingual and multicultural environment	Cost of commercial and professional networks	the personal income tax system
a developed communication network	Research & Development at industry level	the corporate tax system
developed transportation networks	Cost of registration of Intellectual Property Rights, patents	the administration of public department/agencies
availability of commercial and professional networks	Administration of Intellectual Property Rights, patents	Government & public policies

Sources: TBSF database, own calculation.

5.8. Conclusion

The main characteristics of the companies in our sample are that employment and profits net of taxation do not follow the same trend. Indeed, employment may decrease while results after taxes may remain constant. Only a few companies enjoy growth in both employment and results after taxes between 1998 and 2003. The great majority of companies were less than 5 years old in 2002.

Technology transfers are very important in high-tech companies particularly in relationship to universities. According to Capron and Cincera (2003), information from universities appears to be very important in Belgium as compared to the European average. Indeed, the results of the TBSF sample show the importance of this relationship between high-tech companies and universities: 32 companies out of the

sample have been created on the basis of university research. Moreover, more than 50 percent of the firms active in R&D are involved in active cooperation with a higher education institution.

On the financing front, our findings suggest that internal finance in the form of personal funds, as well as the funds of family and friends are the primary source of capital to start-up a high-tech company in Belgium. Entrepreneurs rely on their own personal savings in 84 percent of the cases. The commercial bank loans are the secondary source of finance. This part of external financing (debt-finance) exceeds the combined angel funds and venture capital funds (equity-finance). Concerning the VC funds, this chapter shows that the reliance on VC funding is hindered by different factors. For more than 55 percent of the TBSF, VC is difficult to use due to the unwillingness of VC firms to provide small amounts of capital, their lack of interest in early stage investments, and their expectation of high rates of return and of quick exits.

As for entrepreneurial activities, the preliminary results firstly show that 80 percent of entrepreneurs in this study have a university degree while 42 percent hold post-graduate degrees (i.e. master and doctorate). It seems to be important to stimulate highly educated Belgians to launch innovative enterprises.

More than half of entrepreneurs highlight the availability of multilingual and multicultural environment, developed communication network, developed transportation networks, and commercial and professional networks as strengths in Belgium. Costs of commercial and professional networks, R&D at industry level, costs of registration of intellectual property rights and administration of intellectual property rights let more than half of entrepreneurs neutral. On the other hand some factors in Belgium seem to require policy action. Indeed, these factors are highlighted by more than 60 percent of the entrepreneurs as factors reducing the propensity to create companies, in Belgium. It concerns the personal income tax system, the corporate tax system, and the administration of public department/agencies.

CHAPTER 6:

THE CONTRIBUTION OF UNIVERSITIES TO EMPLOYMENT GROWTH

6.1. Introduction

Belgium suffers from a relatively weak entrepreneurial activity (De Clercq *et al.*, 2002). This is due to several factors, including a broad aversion to risk, a too stringent regulatory environment for firm creation, the lack of venture capital (see e.g. Romain and van Pottelsberghe, 2004b), and a weak government support to entrepreneurial projects. It must however be acknowledged that the recent Marshall Plan implemented by the Région Wallonne formally identifies new supports for high-tech start-ups. The Marshall Plan also devotes substantial funds for academic research and tries to foster university-industry partnership and the effective diffusion of academic knowledge towards the business sector.

The focus by national or regional authorities on academic research and its diffusion to the business sector has been increasing in most European countries over the past 15 years. Government passed Bay-Dohle Act-like regulations (academic inventions subject to patent applications are filed by, and hence belong to, universities, even if the research is sponsored by government institutions), funded the creation of technology transfer offices in most universities, and provided financial support for the creation of spin-offs through academic or regional incubators. The sources of job creation, the ultimate objective of policy-makers nowadays, are increasingly perceived to lay not only into the creation of new firms, but into the creation of high-tech or

science-based companies. These firms are simply believed to generate a sustainable economic welfare.

Indeed, existing studies based on US, UK, Swedish or German data show that small companies are an important source of employment growth. Small and medium-sized companies contribute more than proportionally to the creation of new jobs (see e.g. Birch, 1981; Storey and Johnson, 1987; or Konings, 1995). Besides, the innovative characteristic of firms also plays a role. Innovative companies are frequently amongst the companies with the highest growth potentials in the middle and long term, including in terms of number of employees (see Almus *et al.*, 1999).

The objective of this chapter is to investigate the role of universities, as education and research centers, in the employment performance of Technology-Based Small Firms (TBSF). More specifically, the chapter aims to contribute in three respects to the literature on the determinant of job creation in small technology-based firms. The first one is to perform the analysis with Belgian high-tech start-ups. So far, very few studies have tried to evaluate the various factors underlying the growth of employment in young innovative companies based in Belgium. The second contribution to the existing literature is to include the type of firm (i.e. an academic spin-off) and the origin of the innovative idea amongst the potential determinants of job creation. The third contribution is to adopt advanced quantitative tools to check the robustness of the econometric results.

The broad results tend to confirm the important role played by universities, as academic spin-offs have a larger rate of job creation than non-academic spin-offs. This result must however be taken with caution, as small firms, and especially high-tech ones, are extremely volatile. Relying on more robust estimation methods lead to drastic changes in the results, calling for very tentative conclusions.

The chapter is structured as follows. The next section focuses on the existing empirical literature attempting to better understand the determinants of employment performance at the firm level. Section 6.3 describes the data. The empirical model is presented in the section 6.4. In section 6.5 different econometric results are presented and interpreted. The final section draws some concluding remarks.

6.2. State of the art

The empirical literature on the development of companies is abundant. A first conclusion that can be directly drawn is that the concept of growth itself and its measure is not commonly defined. For instance, a comparison of employment and sales variables has been made by Janssen (2004). He shows that employment and sales are in fact not identical approximations of the concept of companies' performance because they are determined by different factors. The author clearly shows that many inconsistencies due to this measurement issue are encountered in the empirical literature. In this chapter, the focus is on the companies' performance in term of employment. One reason for this choice finds its roots in Audretsch (2002), who suggests that the most prevalent firm level performance measure in the literature is employment growth. A second reason is implied by the importance given by public governments to new innovative firms. Indeed, technology-based small firms have been expected to overcome the labour market problems and to contribute to economic development.

The growth rate of employment is used as dependent variable by Jo and Lee (1996), Manigart (1996) and Almus *et al.* (1999) in their econometric studies. However, Mata (1996), Colombo and Grilli (2005a), and Barkham (1994) use a variable of employment level to proxy the performances in term of firm size. The variables used by all these authors in order to explain performance in terms of employment are brought together in Table 6.1. Three categories of variables are traditionally used: founder-specific factors (such as demographic characteristics, education, and professional experience), company-specific, financial and environmental factors (such as characteristics of the company and of the industry, R&D, patents, venture capital, governmental support, and collaborations) and other factors (such as density of population, employment rate, and concentration index).

Table 6.1: Literature on performance in term of number of employees

Authors (Year)	**Sample**	**Econometric method**	**Dependent variable**	**Independent variables**		
				Entrepreneur	***Company***	***Other***
Barkham (1994)	304 companies - UK -	Cross-Section OLS	$\log\left(\#\,founders + \#\,employees\right)_{t_3}$	- Education - Work skills - Motivations	- Industrial sector - Region - Information	/
Jo and Lee (1996)	48 companies - Korea -	Cross-Section OLS	$mean\begin{pmatrix}(\#employees_{t_3}/\#employees_{t_1}),\\(\#employees_{t_4}/\#employees_{t_1}),\\(\#employees_{t_5}/\#employees_{t_1})\end{pmatrix}$	- Education - Managerial experience - Experience in the line of business	/	/
Manigart (1996)	818 companies - Belgium -	Cross-Section OLS	$\log\left(\#employees_{1992}/\#employees_{1985}\right)$	/	- Ratios of balance sheet data - Ratios of profits & losses data - Size data - Additional information (i.e. legal form, subsidiary)	/

Table 6.1: Literature on performance in term of number of employees (continued)

Authors (Year)	**Sample**	**Econometric method**	**Dependent variable**	**Independent variables**		
				Entrepreneur	***Company***	***Other***
Mata (1996)	766 manufactures (Portuguese Ministry of Employment Database) - Portugal -	Cross-Section OLS	$\log(\#employees)_t$	- Age - Education - Gender	Industry characteristics: - Economies of scale - Growth - Turbulence	/
Almus *et al.* (1999)	8739 manufactures (ZEW database) - Germany -	Cross-Section Bivariate Tobit	$(\log(\#employees)_{t2} - \log(\#employees)_{t1}) \big/ (t2 - t1)$	- Team - Skills	- Size - Age - Legal form - Industry - Innovative start-ups (dummy)	- Density of population - Employment rates - Concentration Index
Colombo and Grilli (2005a)	391 high-tech companies (RITA[52] database) - Italy -	Cross-Section OLS	$\log(\#employees)_t$	- Education - Professional experience and skills - Specific experience as entrepreneur	- Different mode of financing - Start-up characteristics - Industry	- Socioeconomic environment - Infrastructure in the region

[52] RITA: Research on Entrepreneurship in Advanced Technologies

Variables on entrepreneur and human capital

Several studies investigate the role of **human capital** in the development of companies. Penrose (1959) describes a company as a mix of physical and human resources in which the availability and the quality of managerial resources are sources of growth. Barkham (1994) does not find any significant impact of the variables representing the education level. According to this author, the entrepreneurs who create most jobs are strongly motivated and have good managerial capabilities.

On the other hand, Mata (1996) finds that company size (measured by the number of employees in logarithm) increases with the level of education of entrepreneurs. It seems that better educated people are more likely to be efficient managers. Mata uses the entrepreneurs' age as a proxy for experience in the labour market and finds, conversely to Evans and Leighton (1989), that older entrepreneurs create larger companies. He further shows that there is no significant gender effect.

Three factors of human capital are tested in the multiple regression analysis of Jo and Lee (1996). The first two ones are the level of education of the entrepreneur and his managerial experience. They do not seem to have a significant impact on employment growth rates. The third human capital variable tested is the experience in the line of business, which seems to be positively and significantly correlated with the growth in the number of employees.

For Almus *et al.* (1999), positive effects can be derived from the skills of the founder(s), especially for technological disciplines, whereas business knowledge plays a less prominent role. Colombo and Grilli (2005a) also find a strong link between human capital and employment. The professional experience gained by founders in previous jobs and the entrepreneurial/managerial capabilities of the founding team positively influence their companies' employment level. But as Barkham and Jo and Lee, Colombo and Grilli failed to find a significant impact of the number of years of founders' education.

In a nutshell, it seems that the experience, motivation, and managerial capabilities play a more important role in the growth of firms than pure indicators of the education level of the founding partners. The reason underlying the lack of impact of education levels of the founding partners their firm's employment growth may be due

to the small level of heterogeneity in this variable (most entrepreneurs of high-tech firms being graduated from the higher education sector).

Variables on company and industry

1) Company characteristics

Barkham (1994) tests, with no convincing results, whether the geographical location of the company (i.e. its region in the UK) and of the level of market information held by the entrepreneur play a significant role in explaining differences in the number of employees.

A study on Belgian firms, performed by Manigart (1996), controls for the effect of the size of companies on the growth of staff. The author observes a negative and significant relationship, which contradicts 'Gibrat's law' that assumes no systematic correlation between growth and firm size. In Manigart, the smaller the company is at its start-up, the higher its subsequent growth rate. Moreover, Manigart finds that only the smallest Belgian companies of her sample have on average grown in terms of the number of employees over the period 1985-1992. Neither the legal form, nor the fact of being a subsidiary seems to have had a significant impact.

Almus *et al.* (1999) also find that large and mature firms have smaller growth rates than small and young innovative as well as non-innovative firms. For them - and contrary to Manigart, the legal form and formal links to other firms in Western industrialised countries have a positive impact on the development of start-ups.

To sum up, there seems to be a negative relationship between the size of a firm and its growth, which appears to be logical, especially when longitudinal studies are performed. Indeed, if a company still exists after a number of years, its potential growth in terms of employees is higher than for large firms.[53] However, inconclusive results are observed regarding the status of the firm and its relationship with large firms.

[53] Most existing studies on small firms present a selection bias as they include only surviving firms.

2) Financial characteristics

Manigart (1996) also tests the impact of financial characteristics such as authorized capital on company growth, and no significant impact is found. The author explains this absence of significance by a potential sample selection bias, which only includes surviving companies.

Colombo and Grilli (2005a) using a sample of young Italian firms operating in high-tech industries, find that bank debt-financed firms are not larger in terms of number of employees than firms created only through founders' personal savings. Although only a few of the sampled firms had access to private equity financing, the use of this type of funding by highly qualified entrepreneurs had a strong positive effect on the number of firms' employees measured 12 months after the date on which the new firm was incorporated.

3) Industry characteristics

As far as industry characteristics are concerned, Barkham (1994) shows that the entrepreneurs who create most jobs are those who are active in the manufacturing industry. Almus *et al.* (1999) compare companies active in innovative industries and non-innovative industries. Regarding employment dynamics and growth potential of young firms they conclude that the firms that are active in innovative industries achieve significantly higher growth rates when compared to non-innovative firms.

For Mata (1996), industry characteristics such as its size, hence potential economies of scale, and turbulence have an impact on the size of companies. Larger firms in terms of number of employees are created in larger industries. He shows that the high economies of scale and turbulence in industries have a positive impact on the level of employment.

6.3. Quantitative analyses

6.3.1. The model

Following up the literature review, the net increase in employment in TBSF (ΔEMPL) is assumed to be determined by various factors related to the funding structure, the characteristics of the companies and industries and the founder(s) of the company. Amongst the determinants traditionally used in the literature, two new types of variables are added: the origin of the idea underlying the creation of the company, and whether the company is an academic spin-off or not.

In Equation 6.1, the employment growth in TBSF (ΔEMPL) is explained by the following variables: the characteristics of the company (FIRM), of the industry the firm is active in (INDU), of the financing (FIN), of the type of company (DEF), of the origin of the idea underlying the creation of the company (IDEA) and of the characteristics of the founder (FOUND).

$$\Delta EMPL = f(FIRM,\ INDU,\ FIN,\ DEF,\ IDEA,\ FOUND) \qquad (6.1)$$

Equation 6.2 is the empirical implementation of Equation 6.1:

$$\begin{aligned}\Delta EMPL_i = {} & \beta_c + \beta_{empldeb}\ EMPLDEB + \beta_{agec}\ AGEC_i + \beta_{aeroinst}\ AEROINST_i + \beta_{comp}\ COMP_i \\ & + \beta_{electro}\ ELECTRO_i + \beta_{pharma}\ PHARMA_i + \beta_{authcapm}\ AUTHCAPM_i + \beta_{unifspin}\ UNIFSPIN_i \\ & + \beta_{indep}\ INDEP_i + \beta_{busiex}\ BUSIEX_i + \beta_{busir}\ BUSIR_i + \beta_{univr}\ UNIVR_i + \beta_{unifmaster}\ UNIFMASTER_i \\ & + \beta_{phdpostphd}\ PHDPOSTPHD_i + \mu_i\end{aligned} \qquad (6.2)$$

where Δ represents the absolute increase and μ_i is the error term.

The parameters represent the impact of explanatory variables on employment growth. They are defined as follows:

β_C impact of the intercept

$\beta_{empldeb}$ impact of the employment at the beginning of the analysed period

β_{agec} impact of the age of the company

$\beta_{aeroinst}$ impact of industry: Aerospace and Instruments

β_{comp} impact of industry: Computer

$\beta_{electro}$ impact of industry: Electronic

β_{pharma} impact of industry: Pharmaceutical industry

$\beta_{authcapm}$ impact of amount of authorized capital

$\beta_{unifspin}$ impact of the type of company: university spin-off

β_{indep} impact of the origin of the idea: personal idea

β_{busiex} impact of the origin of the idea: business experience

β_{busir} impact of the origin of the idea: business research

β_{univr} impact of the origin of the idea: university research

$\beta_{unifmaster}$ impact of the education of the entrepreneur/founder: university or master degree

$\beta_{phdpostphd}$ impact of the education of the entrepreneur/founder: Ph.D. or post-Ph.D.

6.3.2. The variables

Dependent variable:

$\Delta EMPL$ is the absolute increase of the number of employees in the company in the analysed period i.e. between 1998 and 2003 or the longest available period. The series come from the TBSF survey. Actually, the Bel-First database and the Graydon database were used to collect additional data on the 103 responding firms.[54] Indeed, some entrepreneurs did not answer to all the questions. As missing data may decrease the number of firms included in the empirical analysis, other sources of information have been used. The final sample, for which complete information is available, is composed of 87 companies.

[54] The Bel-First database is a product of Bureau van Dijk Electronic Publishing. Their company information products propose quality data and software. Bel-First database provides annual reports of firms operating in Belgium and Luxemburg. Graydon Belgium NV has held a leading position in commercial and marketing information, and credit and debt management. Graydon Belgium NV provides concise or highly detailed commercial reports on Belgian and foreign companies.

Company characteristics:

EMPLDEB is the number of employees of the company in the first year of the analysed period (TBSF survey, Bel-First database and Graydon database).

AGEC is the age of the company in years (own TBSF survey).

Type of company:

STARTUP is a dummy equal to 1 if the company is a start-up or a corporate spin-off and 0 otherwise (own TBSF survey).

UNIFSPIN is a dummy equal to 1 if the company is a university spin-off and 0 otherwise (own TBSF survey).

As the two variables are mutually exclusive, only one has been introduced in the model (UNIFSPIN).

Origin of the innovative idea:

INDEP is a dummy equal to 1 if the idea is personal to the founder(s) and 0 otherwise (own TBSF survey).

BUSIEX is a dummy equal to 1 if the idea comes from the business experience of the founder(s) and 0 otherwise (own TBSF survey).

BUSIR is a dummy equal to 1 if the idea comes from business research and 0 otherwise (own TBSF survey).

UNIVR is a dummy equal to 1 if the idea comes from university research and 0 otherwise (own TBSF survey).

These four variables are not mutually exclusive (i.e. the idea at the origin of the creation of the company can come from several sources, for example a private research and the business experience of the founder). The four variables can therefore be introduced simultaneously in the regressions.[55]

[55] The entrepreneurs questioned were given the choice between five possibilities of origin of their innovative idea: Independent (INDEP), Business experience (BUSIEX), Technology used abroad (TECH ABROAD), University research (UNIFR) and Business research (BUSIR). In the econometric

Industry:

AEROINST is a dummy equal to 1 if the company belongs to the Aerospace and Instruments industry and 0 otherwise (own TBSF survey).

COMP is a dummy equal to 1 if the company belongs to the Computer industry and 0 otherwise (own TBSF survey).

ELECTRO is a dummy equal to 1 if the company belongs to the Electronics industry and 0 otherwise (own TBSF survey).

PHARMA is a dummy equal to 1 if the company belongs to the Pharmaceuticals industry and 0 otherwise (own TBSF survey).

OMHT is a dummy equal to 1 if the company belongs to a medium-high-tech sector and 0 otherwise (own TBSF survey).

As these five variables are mutually exclusive[56] and in order to avoid problems of collinearity, we do not introduce the variable 'Other sectors medium-high-tech' (OMHT) in the equation. The other estimated parameters are compared to this category.

Financial characteristic:

AUTHCAPM is the amount of authorized capital; the data comes from the TBSF survey and is checked with the Bel-first and Graydon databases.

For the economic indicators of firms, Bel-First and Graydon databases are used because entrepreneurs frequently avoid to provide this kind of information. The two databases provide the annual reports of all firms in Belgium, or at least (for Bel-First) those for which the publication of accounts is compulsory.

analysis, only four of these five possibilities are tested because, only very few entrepreneurs chose the option TECH ABROAD. The conclusion of the analysis does not change without this variable.

[56] The sum of the 5 binary variables equals 1 for each company.

Characteristics of the entrepreneur

UNIFMASTER is a dummy equal to 1 if the highest educational level attained by the entrepreneur is university degree or a master degree and 0 otherwise (own TBSF survey).

PHDPOSTPHD is a dummy equal to 1 if the highest educational level attained by the entrepreneur is a Ph.D. or a post-doctorate and 0 otherwise (own TBSF survey).

These two variables are part of a broader set of possible educational levels, including no more than high school degree or higher non-university degree of less than 3 years. We will only test the two most frequent educational levels (i.e. university or master degree, and Ph.D. or post-doctorate degree), which together account for 83% of the individuals included in the sample (see Table 6.2).

Survey characteristics:

SURVEYTYPE is a dummy equal to 1 if the data collection method is the interview and 0 otherwise (by mail). The series were collected from the TBSF survey.

The estimates of employment growth over the period 1998-2003 are run on the sample of 87 companies. The period varies slightly across firms, depending on date of creation and on the availability of information. The mean of the dependent variable (employment growth) is 7.74. Only four variables in the model are continuous: the dependent variable (increase in employment), the number of employees at the beginning of the analysed period with a median of 6 employees, the company's age (ranging from 3 to 20 years), and the starting capital with a median of € 62 000. The industrial sectors, the types of company, the possible origins of the innovative idea that led to the creation of the company, the different educational levels, and the data collection methods (mail or interview) are dummy variables. Table 6.2 presents the frequency of these dummy variables.

Table 6.2: Descriptive statistics of the sample of 87 companies

	Mean	**Frequency**
Aerospace and Instruments	0.15	13
Computer	0.26	23
Electronic	0.25	22
Pharmaceutical Industry	0.22	19
Other medium-high-tech industries	0.12	10
Start-up	0.61	53
University spin-off	0.39	34
Personal idea	0.37	32
Idea from business experience	0.37	32
Idea from business research	0.07	6
Idea from university research	0.30	26
University or Master	0.57	50
Ph.D. or post-Ph.D.	0.25	22
Data collection methods (mail or interview)	0.22	19

Sources: own calculation from the 2002-2003 survey

6.4. Empirical results

Table 6.3 presents the parameters of Equation 6.2 estimated with Ordinary Least Squares, as in most existing studies in the literature review. As the variables explaining the role of universities seem to be quite correlated, it has been decided to test them separately. Therefore, the first column relates to the impact of the number of employee at the beginning of the analysed period, the age of the company, the industry and the amount of authorized capital. These variables are taken as control variables and are included in all regressions. In column 2, the type of company is taken into account. Column 3 looks at the model with variables related to the origin of the innovative idea. Finally, the last column presents the impact of the educational level of the entrepreneurs.

Table 6.3: Employment growth estimation results

Dependent variable: Absolute growth of employment (ΔEMPL)

Regression results		1	2	3	4
Constant	*C*	-13.113 *(-1.50)*	-19.116** *(-2.06)*	-9.699 *(-0.97)*	-20.380* *(-1.83)*
Company-specific characteristics					
Number of employees (beginning of the analysed period)	*EMPLDEB*	0.741*** *(3.13)*	0.747*** *(3.20)*	0.646*** *(2.78)*	0.709*** *(2.98)*
Age of the company	*AGEC*	0.192 *(0.36)*	0.394 *(0.72)*	0.433 *(0.75)*	0.357 *(0.62)*
Industry					
Aerospace and Instruments	*AEROINST*	10.451 *(1.15)*	8.662 *(0.96)*	9.467 *(1.07)*	10.385 *(1.14)*
Computer	*COMP*	7.782 *(0.94)*	11.046 *(1.32)*	9.827 *(1.20)*	7.883 *(0.92)*
Electronic	*ELECTRO*	8.694 *(1.06)*	10.529 *(1.29)*	9.866 *(1.24)*	8.245 *(1.00)*
Pharmaceutical	*PHARMA*	20.537*** *(2.55)*	18.707** *(2.33)*	18.620** *(2.33)*	21.785*** *(2.61)*
Financial characteristics					
Authorized Capital ($x10^{-6}$)	*AUTHOCAPM*	-4.38*** *(-4.61)*	-4.38*** *(-4.67)*	-4.05*** *(-4.36)*	-4.31*** *(-4.51)*
Type of company					
University spin-off	*UNIFSPIN*		9.023* *(1.76)*		
Origin of the innovative idea					
Personal idea	*INDEP*			-8.678 *(-1.39)*	
Idea from business experience	*BUSIEX*			-6.357 *(-0.95)*	
Idea from business research	*BUSIR*			20.976** *(2.37)*	
Idea from academic research	*UNIVR*			-2.405 *(-0.35)*	
Founder-specific characteristics					
University or Master	*UNIFMASTER*				8.488 *(1.33)*
Ph.D. or Post-Ph.D.	*PHDPOSTPHD*				4.552 *(0.57)*
R^2		0,359	0.383	0.431	0.374

Note: Data on 87 high-tech companies. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. Econometric method: OLS. T-Statistics in parentheses.

As the dependent variable is related to the increase in the number of employees, the estimates can be compared with similar existing studies (i.e. attempting to understand firm-level employment growth), which include Barkham (1994), Jo and Lee (1996), Manigart (1996), Mata (1996), Almus *et al.* (1999) or more recently Colombo and Grilli (2005a) (cf. Table 6.1). A first overview of the results leads to conclude that the results are broadly in line with the literature.

Two variables have been introduced as to correct the dependent variable. The age of the company controls for the age discrepancy observed in the sample. The employment measured at the beginning of the analysed period is used as a level variable since the difference in the employment level might be large across companies. The results show that the age effect is not proven to be significant while the employment level has a positive and significant impact. Hence, the employment growth depends on the initial level.

The parameters associated with industry dummies show that companies active in the pharmaceutical field enjoy higher than average employment growth. This is probably related to the competitive structure of the pharmaceutical industry that requires companies to reach a minimum size in a short period of time.

The last control variable is a financial variable representing the amount of authorized capital of the TBSF (column 1). We find a negative significant impact on the increase in employment like Almus *et al.* This shows that the smaller the company is at its creation, the higher its subsequent growth rate.

This chapter is mainly interested in the role that universities would play in the development of innovating enterprises. The results suggest that academics spin-offs create more jobs than independent start-ups and corporate spin-offs (Table 6.3, column 2). Besides, companies created on the basis of an idea that originates from the business sector research activities are also subject to an above-than-average increase in employees (Table 6.3, column 3). These results suggest that R&D carried out in business sectors is a prevalent factor in the growth of companies, at least more prevalent than personal ideas or ideas simply arising from business experience. A surprising result is that university research seems not to have a significant impact on employment growth of TBSF.

The results presented in column 4, Table 6.3 show no significant relation between the two education variables and the employment growth rate. This result is in line with Barkham (1994), Jo and Lee (1996) and Colombo and Grilli (2005a).

Two types of tests have been performed to test the sensitivity of the results presented in Table 6.3. First, as some questionnaires have been completed through face to face interviews, and others have been completed individually by the entrepreneurs, it is worth testing whether the two types of data collection would affect the results. Second, as the sample is composed of young TBSF, which by definition are highly volatile and subject to strong yearly variation in their results and performance, it is important to test for the potential impact of outliers in the sample. A formal test of Heckman could not be carried out because the explanatory variables were not available for the total population. However, a simplified test of Heckman was carried out using as selection variable first the provinces and secondly the towns. The results do not show the presence of a selection bias for theses two variables. Hence, neither a geography location nor the language seem to have introduced a bias in the survey answers.

Table A.6.1 (in the Appendix 9.3, page 197) displays the results of the first test by adding a dummy equal to 1 if the questionnaire was filled out at an interview and 0 otherwise. The results are similar to those presented in Table 6.3, and the dummy is not significantly different from zero. It can therefore be concluded that there is no bias induced by the data collection method.

The second test consists in performing the estimates through a more robust approach (the robust MM Linear estimator). It is indeed well-known that the classical ordinary least squares (OLS) estimators may be highly influenced by the presence of a few outliers (see for instance Rousseeuw and Leroy, 1987). Some authors simply look at the residuals of an OLS approach to identify outliers. However the diagnostic can be spurious as outliers might affect the residual series. Hence robust methodologies may prove useful to avoid the influence of hidden outliers. The results obtained through the robust MM Linear method are presented in Table 6.4.[57]

[57] The second methodology uses the robust MM Linear estimator proposed by Yohai (1987). This estimator is robust against outliers and efficient. As all robust estimators, it gives less weight to extreme observations. See Yohai for more details on this methodology.

Table 6.4: Employment growth estimation results (Robust MM Linear reg.)

Dependent variable: Absolute growth of employment (ΔEMPL)				
Regression results		1	2	3
Constant	*C*	0.739 *(0.31)*	1.369 *(0.52)*	1.413 *(0.39)*
Company-specific characteristics				
Number of employees (beginning of the analysed period)	*EMPLDEB*	0.010 *(0.14)*	-0.099 *(-1.48)*	-0.059 *(-0.74)*
Age of the company	AGEC	0.104 *(0.76)*	0.021 *(0.14)*	0.109 *(0.62)*
Industry				
Aerospace and Instruments	AEROINST	1.548 *(0.70)*	0.720 *(0.31)*	2.575 *(0.90)*
Computer	COMP	0.567 *(0.26)*	0.635 *(0.30)*	1.318 *(0.49)*
Electronic	ELECTRO	0.257 *(0.12)*	-1.365 *(-0.62)*	1.260 *(0.47)*
Pharmaceutical	PHARMA	1.633 *(0.75)*	3.188 *(1.46)*	2.667 *(0.89)*
Financial characteristics				
Authorized Capital	*AUTHOCAPM*	0.000*** *(-6.50)*	0.000*** *(8.70)*	0.000*** *(-4.97)*
Type of company				
University spin-off	*UNIFSPIN*	0.306 *(0.22)*		
Origin of the innovative idea				
Personal idea	*INDEP*		1.533 *(0.90)*	
Idea from business experience	*BUSIEX*		-0.695 *(-0.38)*	
Idea from business research	*BUSIR*		-3.185 *(-1.19)*	
Idea from university research	*UNIVR*		-3.183 *(-1.58)*	
Founder-specific characteristics				
University or Master	*UNIFMASTER*			-1.416 *(-0.71)*
Ph.D. or Post-Ph.D.	*PHDPOSTPHD*			-0.884 *(-0.36)*
R^2		0.060	0.083	0.071

Note: Data on 87 high-tech companies. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. Econometric method: Robust MM Linear Regression. T-Statistics in parentheses.

The results are striking because the sign and the significance of most parameters are changed. Only the parameter associated with the authorized capital turns out to have a significant impact on employment growth but with a coefficient close to zero. It thus seems that reducing the heterogeneity in the sample induces large changes in the results. And we must stay careful with our conclusions because TBSF are by definition highly volatile in term of performance for example.

6.5. Concluding remarks

The objective of this chapter was to investigate the role of universities as education and research centres in the employment performance of Belgian technology-based small firms. Taking into account the role of universities can be taken as a contribution to the literature on the determinants of employment growth in small companies. The empirical implementation relied on an original survey of 103 TBSF operating in Belgium in 2002. The quantitative analysis was based on a sample of 87 companies for which all the data were available.

As expected, an important discrepancy is observed between two main performance indicators: the growth in the number of employees and the growth in terms of sales or financial results. The descriptive analysis validates Janssen's findings (2004) that these two variables are not driven by the same factors and frequently contradict each other. In the remainder of the chapter the focus was brought to the increase in the number of employees.

Controlling for the number of employee at the beginning of the analysed period, the age of firms, their industrial sector of activity and their starting authorized capital, the results suggest that both academic spin-offs and TBSF created on the basis of an idea originating from business R&D activities are associated with an above than average growth in employees. In a nutshell, these results underline the importance of R&D activities for the creation of fast growing TBSF.

As far as the education level of the entrepreneur is concerned, no conclusive results are obtained. The fact that the educational level of entrepreneurs does not play any significant role cannot however be taken as an indication of a potentially small role played by higher education institutions. There is indeed a weak heterogeneity in this

variable over the whole sample, with 80% of the surveyed entrepreneurs/founders of TBSF being well educated, i.e. holding at least a university or a master's degree.

Janssen (2004) already observes that many inconsistencies can be encountered in the existing empirical literature, inconsistencies implied by the choice of the dependent variable for the estimates: the number of employees or financial results. The results presented in this chapter turn out to suggest that an additional source of inconsistencies may be driven by the econometric method used to perform the estimates. Indeed, when relying on an alternative and robust method for the identification of outliers, the results drastically change, and annihilate somewhat the conclusions drawn here above. This methodology basically consists in giving less 'weights' to extreme observations. In other words, reducing the heterogeneity in the sample of high-tech firms, which induces a sharp drop in the significance of the parameters, leads to results that forbid even tentative conclusions about the factors that drive employment growth in TBSF. Such firms are by definition highly volatile, some of them displaying extremely good performances, and others disappearing fast, while the majority seem to 'survive'.

Although the descriptive statistics in chapter 5 show the importance of the relationship between high-tech companies and universities, from an econometric point of view, the impact of universities through spin-off creation, research and education on employment growth is difficult to show for TBSF. On the contrary, theoretical approaches and case studies generally tend to show the importance of academic research (Peeters *et al.*, forthcoming; Leydesdorff and Etzkowitz, 1998; and Jaffe, 1989) In any case, what this chapter clearly suggests, and which was already underlined by the state of the art, is that one should be highly cautious when interpreting quantitative analyses aiming at better understanding the factors that drive the performance of young technology-based firms. These firms are by definition highly volatile, and therefore difficult to understand.

CHAPTER 7:

CONCLUDING SUMMARY AND POLICY IMPLICATIONS

The first section of the concluding chapter reviews the main findings arising from the three questions asked in this work: What is the impact of the stock of high-risk finance on the productivity of an OECD country? What explains the large differences in the VC intensity from one country to another? What is the role played by universities in the growth of employment in TBSF? This chapter also proposes some ideas for future research. In the second section, recommendations for policy-makers are drawn from our results and from some findings found in the literature.

7.1. Main findings

"Venture capital contributes to economic growth"

The first part of this work has analysed two aspects of the Venture Capital (VC) industry. Chapter 2 investigated and evaluated the macroeconomic impact of venture capital stock in OECD countries. This chapter actually answers the first main question of the thesis, i.e. what is the impact of the VC stock on the total-factor productivity? In this study, the VC stock represents entrepreneurial experience and the venture capital funds of the country.

This chapter shows that, in several respects, VC can be considered to be similar to experimental development performed by large firms. Their R&D activities are indeed

relatively similar to the activities that are performed in small innovative companies. This chapter constitutes a first attempt to evaluate the economic impact of VC stock. The econometric results confirm our theoretical hypothesis that VC contributes to growth through two main channels. The first one is the introduction of new products and processes on the market. The second one is the development of an improved absorptive capacity of the knowledge generated by private and public research institutes.

Another important result of this chapter is the relatively large social return to VC. It is indeed much larger than the return of business or public R&D, probably due to a high risk premium and potential spillovers or knowledge externalities. Furthermore, a high VC intensity increases the economic impact of private and public R&D capital stocks. In other words, VC improves the "crystallisation" of knowledge into new products and processes.

According to our estimates, VC must be considered as an additional factor explaining variations in economic performance. In line with Audretsch and Keilbach's (2003) conclusions, our empirical results confirm Baumol's conjecture that entrepreneurial activity accounts for a significant part of the "unexplained" residual in the traditional production function.

An area for further research would be to create a larger database, broader in two respects. Firstly, adding more recent years would enable to analyse the effect of new technologies that are increasingly high-tech. Secondly, completing the database with observations detailed at a regional level would allow identifying the VC impact on MFP more precisely.

"VC depends on several factors, including technological opportunities"

The second topic of this dissertation concerns the development of a theoretical model of the factors affecting the demand and supply of VC. Indeed, chapter 3 identifies the main determinants of venture capital intensity in OECD countries in order to try to answer to the second question i.e. what factors explain the heterogeneity of VC intensity across countries?

After having developed a theoretical model that takes into account the supply-side and demand-side variables of VC intensity, we simultaneously introduce in the regressions traditional determinants of VC and new potential determinants such as the cost of capital, the level of entrepreneurship, and new proxies aiming to measure technological opportunities.

The main conclusion of this chapter is that VC is pro-cyclical, i.e. it follows a similar evolution as the GDP growth rate. In periods of high growth, the flow of VC outperforms the GDP growth rate, and *vice versa*. This cyclical reaction of VC is reduced by the degree of labour market rigidities. A high level of labour market rigidity reduces the positive impact of GDP growth on VC intensity, as well as the positive impact of the knowledge capital stock on VC.

The most important contribution of this third chapter to the existing literature is to show that indicators of technological opportunity are critical for VC development. The stock of knowledge available and the number of high value patents (triadic patents) influence significantly the amount of VC invested in a national economy. The positive impact of the stock of knowledge is strongly reinforced in countries where the rate of entrepreneurship is very high.

Further research could try to incorporate educational data in the panel. Indeed, demand for VC mainly comes from Technology-Based Small Firms (TBSF). High-technology start-ups are developed only if there is appropriate and sufficient human capital to generate new ideas. Therefore, a highly educated human capital in an economy is probably associated with higher venture capital activities. One possibility is to use the number of patent applications as a proxy for human capital endowment, as Schertler (2003) did with the European Patent Office (EPO). However, in our view, the patent variable (i.e. patents applied at the United States Patent and Trademark Office, the Japanese Patent Office and the European Patent Office) is more a proxy for technological opportunity than for education. A more appropriate human capital endowment could be the measurement of educational attainment by levels of schooling like in Barro and Lee (1993, 1996, 2001).

Another area for further research would be to test other possible determinants of VC intensity to complete the model. The strength of the IPR system or the degree of deregulation of the economy could, for example, be added. Moreover, another dependent variable than the VC intensity could be tested, such as the deal flow (the

number of investments introduced in funds of investment). Contrarily to the volume of investments approached by the VC intensity, this variable allows measuring the quantity of opportunity.

"Spin-offs contribute to employment growth in TBSF"

As explained in the introduction of this work, entrepreneurship is perceived by all policy makers as a crucial factor underlying economic growth. Indeed, innovative entrepreneurial activity contributes to the quality of life, the employment and economic growth. Therefore, the second part of this dissertation focused on employment in Belgian TBSF.

In order to answer the third question of this work, (i.e. what is the role of universities in the development of employment in the TBSF?), we have reviewed the empirical literature on firms' performances and launched a survey of TBSF in Belgium. One objective of this research was to create a new database of Belgian TBSF as to better understand the key socioeconomic determinants of entrepreneurial activity and the extent to which TBSF face important constraints in raising financial resources in Belgium. A unique dataset composed of answers from 103 small Belgian technology-based firms established between 1985 and 2002 has been created.

The main characteristics of companies in the sample are studied in chapter 5. The first result is that employment and profits net of taxation follow different trends. Indeed, employment may decrease while results after taxes may remain constant. Only few companies enjoy a growth in both employment and results after taxes between 1998 and 2003.

A second important result is that technology transfers are very important in high-tech companies particularly in relationship to universities. According to Capron and Cincera (2003), information from universities appears to be very important in Belgium as compared to the European average. Our analysis of Belgian TBSF confirms the close relation between high-tech companies and universities: 32 companies out of the sample have been created on the basis of university research. Moreover, more than 50 percent of the firms active in R&D are involved in active cooperation with a higher education institution.

A third result of chapter 5 is that internal finance in the form of personal funds and funds from family and friends are the primary source of capital to start a high-tech company in Belgium. Entrepreneurs rely on their own personal savings in 84 percent of cases. Commercial bank loans are the secondary source of financing. It is interesting to note that this part of external financing (debt-finance) exceeds the combined angel funds and venture capital funds (equity-finance). Concerning the VC funds, this chapter shows that the reliance on VC funding is hindered by different factors. For more than 55 percent of the TBSF, VC is difficult to use because of the unwillingness of VC firms to provide small amounts of capital, their lack of interest in early stage investments, and their expectation of high rates of return and quick exit. As accessing necessary VC funds seems to be challenging for many companies, it is important to propose actions the government could take to improve the situation. The next section of this concluding chapter discusses possible avenues to stimulate the supply-side and the demand-side of VC.

A fourth result concerns the entrepreneurs themselves. 80 percent of entrepreneurs have a university degree and 42 percent hold post-graduate degrees (i.e. master's, and doctorate). High education therefore seems to be an important channel to stimulate Belgians to start innovative enterprises.

The more general question of the role played by universities for TBSF employment is empirically studied in the last chapter of the thesis. Chapter 6 actually investigates the role of universities in the employment performance of Belgian technology-based small firms. Taking universities into account is a major contribution to the literature on the determinants of employment growth in small companies. The empirical study uses the original survey data described in chapter 5 on 103 TBSF operating in Belgium in 2002. The quantitative analysis is based on a sample of 87 companies for which all the data were available.

Surprisingly, as far as the educational level of the entrepreneur is concerned, no conclusive result is obtained. This might be due to the specificity of our sample (with 80% of the surveyed entrepreneurs/founders of TBSF being well educated, i.e. holding at least a university or a master degree).

The results presented in this chapter suggest that an additional source of inconsistency may be driven by the econometric method used to perform the estimates. Indeed, reducing the heterogeneity in the sample of small high-tech firms induces a sharp drop

in the significance of the parameters. As TBSF are by definition highly volatile, with some displaying extremely good performances while others disappear fast and the majority seems to 'survive', we must stay very careful in drawing conclusions.

Further research could concentrate on two points. Firstly, the TBSF database could be converted into a panel database so that the company development could be monitored. Indeed, more jobs might be created after a time of adaptation to technology. Moreover, very young companies are principally based on high-tech knowledge, but people with competencies in technologies may be less capable in management, at least in the short term. Secondly, it would be very interesting to survey the companies at the establishment of their activities because a lot of companies disappear in the very first years of their existence. Surveying the companies at an earlier stage will enable to avoid the survival bias identified in many empirical studies.

7.2. Policy implications

The results presented above have a number of important implications for policy makers. The literature in general and this thesis in particular show the importance of VC and TBSF in the development of the economy. VC has a positive macroeconomic impact on productivity and the development of TBSF has a positive impact on both productivity and on the rest of the economy. In Belgium, both could be more developed. Since the promotion of TBSF as agents of the New Economy has become a major policy objective of most developed nations, this section concentrates on how policy could be used to promote VC and the development of TBSF.

Governments can intervene in both the demand and the supply of entrepreneurship and VC. Intervention in both cases may be different, but the objective is quite similar. European countries have to boost entrepreneurial initiatives and promote a bigger venture capital industry in order to better compete with the United States and Japan in the creation of new firms and new jobs. As explain in the introduction, it is important to develop favourable conditions in Europe and governments have several ways to intervene in the economic process.

"The supply-side of entrepreneurial activity"

First, governments may act on the capacity and characteristics of potential entrepreneurs. Since the entrepreneurial education plays an important role in the creation of new high-tech companies, governments can act on the education system and the training of potential entrepreneurs. Indeed, a restricting factor to the creation of new companies is the availability of competent people to become entrepreneurs. Rasmussen and Sorheim (2005) argue that universities can address this need by increasing the motivation and competence of their graduates to become key persons in innovative and entrepreneurial activity. Holloway (2000) notes that contrary to what is done in Europe the best method of teaching entrepreneurship is through the analysis of case studies. According to him, if we want to change the culture and mentalities, all the courses related to the creation of companies must provide students with images of entrepreneurs who succeeded. According to Rasmussen and Sorheim, the entrepreneurial education has to become more action-oriented in order to emphasize learning by doing, in contrast to traditional teaching individuals. In other words, educational programs and training in entrepreneurship must be more action-oriented and should be strongly promoted by the government.

Second, European countries have to increase the aspiration and willingness of people to become entrepreneurs. But the entrepreneurial culture of a country is a very difficult thing to change. As the statistics of chapter 5 show, the bureaucratic burden associated with the creation and the growth of a company should be reduced. Authorities should also introduce entrepreneurial knowledge in the educational system to accustom the students to the concepts of entrepreneurship. This could change the culture and contributes to the development of students' spirit of undertaking.

Third, policy makers can act on the risk-reward profile of entrepreneurship. For that purpose they have amongst other things to work on the bankruptcy legislation. Indeed, Surlemont *et al.* (1999) remind that it may be constructive to provide entrepreneurs with a better incentive system such as lower taxes, less bureaucracy and more flexibility. Nevertheless, they explain that the most binding constraints against company creation may be related to failure. Their paper attempts to identify features of national bankruptcy legislations as drivers of or constraints to entrepreneurial behaviour, analysing the relationship between on the one hand the rates of company creation and of bankruptcy and on the other hand the characteristics of the

bankruptcy legislation. Failure is part of the environment of entrepreneurship and many countries still lack effective personal bankruptcy laws. According to Surlemont *et al.*, the environment offered to many entrepreneurs in Europe is risk heavy and reward poor, dampening potential entrepreneurial behaviour. It is commonly known that a significant number of companies will not be successful. One of the main differences in how entrepreneurship is considered in Europe and the United States is the acceptance of failure. Surlemont *et al.* and Hellmann (2000) explain that in Anglo-Saxon systems, everyone agrees that failure is not always fully the responsibility of the entrepreneur. Therefore, entrepreneurs with proven competence and managerial capacities often will be given a second or a third chance. In European countries, the responsibility is often attributed to the individual and the entrepreneurial effort. According to Surlemont *et al.*, such approach, if instinctively appealing, is also utterly non-constructive, preventing the initiation of high risk but potentially extremely high reward ventures. The bankruptcy in Europe needs to be regarded differently, as a learning opportunity and not just a great failure encountered by the entrepreneur. A first step to change this mentality might be to improve bankruptcy legislation in European countries.

"The supply-side of venture capital"

Authorities can also act on the availability of resources to entrepreneurs. Developing VC in a country is important as it has been shown in the literature that they have a positive macroeconomic impact on technological innovations. Moreover, chapter 2 of this dissertation has also shown the importance of VC for total productivity. These results therefore call for innovative policy instruments aiming at the stimulation of the participation of VC funds available on the market. Moreover, the literature has strongly associated the growth of high-tech young firms to the existence of a developed and vigorous venture capital industry. Discussions on capital for young but high potential firms tend to focus on the limitations in the provision of VC (Lockett, Murray and Wright, 2002).

In this thesis, our results call for the encouragement of direct public interventions as a complement to private venture capital. This is confirmed by Leleux and Surlemont (2003) who argue that public direct interventions, irrespective of their rationale, appear to be beneficial to the industry as a whole. Indeed, public involvement seems

to cause greater amounts of money to be invested in the industry as a whole. However, their analysis shows that public intervention in the venture capital industry tends to be the consequence of the industry development rather than its cause. They argue that public sector participation tends to cause larger amounts to be raised for venture capital investments overall. Moreover, they explain that public venture capitalists tend to invest more often in later-stage deals in industries with large human resource needs.

Finally, authorities can act on the supply of VC by using other policies such as modifying the pension system in Europe. According to Belke, Fehn and Foster (2003), the pension system could be capitalized to a greater extent and pension funds could be allowed to invest parts of their assets in VC firms. Based on the US example, this should strongly enhance the development of the VC market in continental Europe. Unfortunately, in this thesis, as we do not know the origin of the VC funds, the econometric analysis of the third chapter could not test the pension funds impact on VC intensity.

"The demand-side of venture capital"

Since VC has a positive macroeconomic impact on productivity, the stimulation of VC in a country is important. Moreover, we have shown that demand-side factors have to be taken into account. In chapter 3, we have found that the most important factors affecting the demand of VC are the stock of knowledge, innovative output proxied by the number of triadic patents and the level of entrepreneurial activity. More intense technological opportunities and research efforts have a positive and significant impact on the level of VC intensity as well. Therefore, both public and private research should be encouraged in order to stimulate the demand of VC. Moreover, the property of highly valued intellectual assets seems to stimulate the demand for VC. Therefore, patent applications must be encouraged. The survey of TBSF in Belgium shows that the cost of patenting, limited financial and human resources, lack of in-house competence, lack of secrecy, imitation, low value creation because of no development, and administration costs negatively affect the patenting process. A majority of entrepreneurs find that the level of patenting fees and costs of protection are too high. Experts in this matter should probably focus on this issue.

Others possibilities for the public sector to improve the demand of VC are to act on the labour market rigidities and to promote entrepreneurial activities. Concerning labour market rigidities, our study of the determinants of VC intensity has shown that the level of labour market rigidities plays an important role. It reduces the positive impact of the stock of knowledge and the GDP growth rate on the intensity in VC of a country. Strategies aimed at exerting leverage on these factors would require adjustment in structural policies on the labour market, the impact of which can only become apparent in the long run.

Another way for the public sector to impact the VC market is to promote the level of entrepreneurial activity. Indeed, a strong entrepreneurial culture improves the positive effect of the stock of knowledge on VC intensity. Moreover TBSF help guarantee the future economic performance of an industry or a nation. Indeed, high-tech companies generate knowledge, competence and a demand for quality services and intermediate products that have significant repercussions on the rest of the economy.

"The demand-side of entrepreneurial activity"

Since they create technological opportunities, all the policies aimed at fostering research are important. Therefore, another possible way for governments to promote high-tech entrepreneurship is through the development of university spin-offs. As explained by Nlemvo *et al.* (2002), one of the most promising ways to transfer research results to the market place is the creation of academic spin-offs. Chapter 5 has also revealed the importance of technology transfers between universities and TBSF. In the USA, the phenomenon has been popularised by the development of the *Silicon Valley* and *Route 128.* Therefore, Nlemvo *et al.* provide some guidelines to organise instruments such as liaison offices, entrepreneurship centres, venture capital funds and incubators in and around universities, in an effort to spur entrepreneurship and favour the creation of value from academic research in Europe.

"The need for data"

Finally, we argue that governments should initiate the development and the updating of a national database on TBSF in addition to the previously identified actions on the supply- and the demand-side of both VC and entrepreneurial activity. A drawback and constant barrier to micro-economic analysis of TBSF is the availability of data. Such a database would systematically include data on the three main factors of development of TBSF: the framework conditions including the R&D activities of firms, the financing and the founders. By allowing a better understanding of the problems faced by these companies, the database would help finding appropriate solutions to support them in the future. At the moment of creation of a company (when a VAT number is attributed), the founders could be asked to fill out a questionnaire on the framework conditions and the financing of this new company, as well as on their own profile. The results would be stored in a database, preferably managed by a central authority and would enable to monitor the development of entrepreneurial activities.

CHAPTER 8:

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CHAPTER 9:

APPENDICES

9.1. Appendix - The economic impact of venture capital

Construction of the data

$$SVC_t = \frac{vc_t}{1-\lambda(1-\delta)} \qquad (2.3'.4.)$$

where SVC_t = VC capital stock at time *t*.

vc_t = VC investment at time *t*.

δ = Depreciation rate (constant over time).

$\lambda = \frac{1}{1+\eta}$ and η is the mean annual rate of growth of vc_t.

As the depression rate is less than 1, the higher λ, the smaller is the denominator of Equation 2.3'.4. In the following table (Table A.2.1), we present the multiplicator λ, computed for each depreciation rate.

Table A.2.1: Multiplicator with different depreciation rates of VC stock

	$\lambda = 1/(1+\eta)$			
Country	**δ = 15%**	**δ = 30%**	**δ = 45%**	**δ = 60%**
Australia	8.49	3.66	2.33	1.71
Belgium	4.10	2.65	1.96	1.55
Canada	2.72	2.09	1.69	1.42
Denmark	4.24	2.70	1.98	1.56
Finland	2.71	2.08	1.69	1.42
France	5.37	3.03	2.11	1.62
Germany	3.12	2.27	1.78	1.47
Ireland	4.54	2.80	2.02	1.58
Italy	4.99	2.93	2.07	1.60
Japan	4.62	2.82	2.03	1.58
Netherlands	3.68	2.50	1.89	1.52
Norway	2.04	1.72	1.49	1.32
Spain	4.61	2.82	2.03	1.58
Sweden	4.00	2.62	1.94	1.55
United Kingdom	5.88	3.16	2.16	1.64
United States	4.24	2.70	1.98	1.56

Sources: Based on EVCA and OECD

Robustness of the model

In the following table, we have used 3 different samples. Column 1 reproduces the results from the most appropriate estimates which include the three sources of knowledge, the two control variables, as well as country and time dummies. This sample is an unbalanced one. The sample of column 2 is also an unbalanced one; furthermore we omitted the countries for which we had few data (i.e. Japan, Begium, Canada and Australia). Column 3 presents the results with a feasible GLS specification (Beck and Katz estimator) correcting for both cross-section heteroscedasticity and contemporaneous correlation. Column 4 shows results for a balanced sample with the same 12 countries as in column 2 and 3.

Table A.2.2: Multifactor productivity estimation results in log-levels with different samples

Dependent variable: Log MFP					
Regressions		**1**	**2**	**3**	**4**
The econometric method		**GLS**	**GLS**	**GLS** Beck and Katz	**GLS**
Log Venture capital stock (t-1)	$\delta = 30\%$ *LSVC*	0.009***	0.011***	0.009***	0.011***
		(2.92)	*(3.31)*	*(2.53)*	*(3.33)*
Log Business R&D capital stock (t-1)	*LSBRD*	0.199***	0.199***	0.204***	0.187***
		(12.18)	*(11.77)*	*(11.60)*	*(10.59)*
Log Public R&D capital stock (t-2)	*LSPRD*	0.136***	0.115**	0.160***	0.109**
		(2.92)	*(2.19)*	*(3.59)*	*(2.03)*
Control variables					
Employment rate growth (t)		0.629***	0.559***	0.781***	0.571***
		(3.57)	*(3.19)*	*(4.69)*	*(3.41)*
German reunification dummy (t)		-0.012	-0.007	-0.011	-0.007
		(-0.34)	*(-0.197)*	*(-0.28)*	*(-0.190)*
Country-specific intercept		Yes	Yes	Yes	Yes
Time dummies		Yes	Yes	Yes	Yes
Adjusted R-squared		0.971	0.943	0.947	0.938
		Unbalanced sample	Unbalanced sample	Unbalanced sample	Balanced sample
		16 countries	12 countries	12 countries	12 countries
		1990-2001	1990-2001	1990-2001	1990-1999
		148 obs.	131 obs.	131 obs.	120 obs.

Note: Panel data. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. T-Statistics in parentheses.

The results of these regressions are not significantly different from the results presented in chapter 2. That means that the inclusion of the four countries with the smallest temporal coverage (Australia, Belgium, Canada and Japan) does not change the significance and the sign of the coefficients obtained with the largest sample.

9.2. Appendix – TBSF: Empirical implementation and survey in Belgium

The sources of information and access links used to create the company address book are the following:

1.) Belgian universities spin-off company listings:

Universite Libre de Bruxelles
(http://www.ulb.ac.be/preview/rech/spin-off/index.html)

Vrije Universitiet Brussel
(http://rd-ir.vub.ac.be/valorisatie/KickOff7okt03/KickOff7okt03_BDG.pdf)

Universitiet Antwerpen
(http://www.ua.ac.be/main.asp?c=*ENG&n=745)

Universitiet Gent
(http://www.ugent.be/en/research/technology%20transfer/industry)

Katholieke Universitiet Leuven
(http://www.kuleuven.ac.be/lrd/about/mission.html)

Universite catholique de Louvain
(http://www.parc.ucl.ac.be/locked/enindex_frg.html)

Universite de Liege
(http://www.ulg.ac.be/entreprises/english/valorisation/spin-off-acceuil.html)

Universiteit Limburg
(http://www.luc.ac.be/onderzoek/interfacedienst/luc_spinoff.asp)

2.) Interuniversity organizations spin-off listing:

Park Scientific de l'ULB
(http://www.ulb.ac.be/preview/rech/parcs/index.html)

Flanders Interuniversity Institute for Biotechnology-VIB
(http://www.vib.be/VIB/EN/)

Interuniversity MicroElectronics Center-IMEC
(http://www.imec.be/wwwinter/business/listspinoff.shtml)

3.) Trade organizations and associations membership directories:

Belgian Venturing Association-BVA
(http://www.bvassociation.org/)

Belgian Multi-Sector Federation for the Technology Industry-AGORIA
(http://www.agoria.be/gen-en/home-en.htm)

Federation of Chemical Industries of Belgium-FEDICHEM
(http://www.fedichem.be/EN/AFF/affen.htm)

Belgian Biotechnology Association-BBA
(http://www.bba-bio.be/common/bba_members_list.asp)

European Venture Capital Association-EVCA
(http://www.evca.com/html/member_search.asp)

European Space Agency-ESA
(http://smed.esa.int/)

Union of Industrial and Employers' Confederations of Europe-UNICE
(www.unice.org)

4.) Incubators and technology park companies:

Liege Science Park
(http://www.ulg.ac.be/entreprises/english/parc/index.html)

Antwerp Innovation Centre n.v Research park Waterfront
(http://www.antwerpinnovation.com)

Flanders Science and Technology Parks
(http://www.gomantwerpen.be/engels/e_pub/fbn/archief/winter2001.html)

Wallonia Science Parks
(http://www.investinwallonia.be/an/biotechnologie/potentiel01.htm

MBrussels (incubator) Village
(http://www.m-brussels.com/)

Technopol
(http://technopol.lrt.be/)

Wallonia Region "4x4 Entrepreneur" Workshop Participants (2202): Participating company listings
(http://www.4x4entreprendre.be/)

5.) BEL-FIRST, Belgian companies database

Bel-First: Belgian Companies Information Database CD and DVD (Bureau van Dijck)

Survey questionnaire in English

CONFIDENTIAL

SURVEY: TECHNOLOGY-BASED SMALL FIRMS (TBSFS) IN BELGIUM

We would like to take this opportunity to thank you for accepting to be a part of this Nationwide survey on technology-based small firms (TBSFs) conducted by Solvay Business School, Université Libre de Bruxelles.

The primary objectives of this study are to understand the key socio-economic determinants of entrepreneurial activity and the extent to which TBSFs face important constraints in raising financial resources in Belgium. The recommendations of this study shall be used to enhance our current advisory work to various Belgian government and international agencies including the European Commission and OECD.

Respondent, please complete:

Name: _____ Firm: _____ Position: _____

Tel: _____ E-mail: _____ Fax: _____

PART 1 – COMPANY INFORMATION

1.1. Please Complete for Your Firm:

1. Address: _____ City:_____ Code: |__|__|__|__|
2. Year of Establishment: |__|__|__|__| VAT Number: |__|__|__| |__|__|__| |__|__|__|
3. Legal Form: ❒ *Sprl* ❒ *SA* ❒ *Other(pls. Specify):* _____
4. Authorized Capital at the time of Establishment (x000 Euro):
   ❒ *10– 149* ❒ *150 – 249* ❒ *250 – 350* ❒ *More than 350*

5. Main Sector of Activity:	*Manufacturing*	*Services*
Aerospace	❒	❍
Computers and office machinery	❒	❍
Electronics and telecommunications	❒	❍
Pharmaceuticals	❒	❍
Scientific instruments	❒	❍
Electrical machinery	❒	❍
Chemicals	❒	❍
Non-electrical machinery	❒	❍
Motor vehicles and other transport equipment	❒	❍
Other (pls. specify): _____	❒	❍

6. Total Staff Size:	*2000*	*2001*	*2002*
Less than 5	❒	❒	❒
5 - 10	❒	❒	❒
11 - 25	❒	❒	❒
26 – 50	❒	❒	❒
More than 50	❒	❒	❒

7. Annual Turnover/Total Sales Revenue (Euro):	*2000*	*2001*	*2002*
Less than 1.000.000	❒	❒	❒
1.000.000 – 2.999.999	❒	❒	❒
3.000.000 – 4.999.999	❒	❒	❒
5.000.000 – 7.000.000	❒	❒	❒
More than 7.000.000	❒	❒	❒

8. Annual Balance Sheet Total (Euro):	*2000*	*2001*	*2002*
Less than 1.000.000	❒	❒	❒
1.000.000 – 2.999.999	❒	❒	❒
3.000.000 – 5.000.000	❒	❒	❒
More than 5.000.000	❒	❒	❒

9. Number of Founders at the time of Establishment:
   ❒ *1 - 2* ❒ *3 – 4* ❒ *5 – 6* ❒ *7 – 8* ❒ *More than 8*

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10. Number of Founders with 25% or More Ownership at the time of Establishment: |__|__|
11. Subsidiary or Branch of a Parent Company: ❒ *Yes* ❒ *No*
    If Yes, please indicate Name of Parent Company:_____
12. Countries/Regions of Business Activity:
    ❒ *Belgium* ❒ *France* ❒ *UK* ❒ *Other EU* ❒ *USA* ❒ *Rest of World*
13. Does your firm perform Research & Development (R&D) activities? ❒ *Yes* ❒ *No*
14. Does your firm collaborate in R&D with Belgian higher education institutes/universities? ❒ *Yes* ❒ *No*
15. Does your firm collaborate in R&D with Belgian public research centres? ❒ *Yes* ❒ *No*
16. Does your firm take advantage of government/public R&D subsidies? ❒ *Yes* ❒ *No*
17. Does your firm benefit from R&D tax credit facility? ❒ *Yes* ❒ *No*
18. What (broad) percentage of your annual budget spent for R&D? |__|__|__| %
19. Broad Percentage of R&D projects that are exploited commercially through own production: |__|__|__| %

1.2. We do not <u>patent</u> our inventions systematically because: *(Please rate how strongly you **Agree** or **Disagree** with each of the following statements by placing a check mark in the appropriate box).*	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
1. Cost of fees is high.	❒	❒	❒	❒	❒
2. Cost of protection is high.	❒	❒	❒	❒	❒
3. Protection not efficient due to the lack of confidence in the system.	❒	❒	❒	❒	❒
4. Secrecy is more efficient.	❒	❒	❒	❒	❒
5. Market lead is more efficient.	❒	❒	❒	❒	❒
6. Product life cycle is short.	❒	❒	❒	❒	❒
7. Invention disclosure is risky.	❒	❒	❒	❒	❒
8. Inability to prevent other firms from copying the technology.	❒	❒	❒	❒	❒
9. No information or know-how on the patenting process.	❒	❒	❒	❒	❒
10. Administration is slow.	❒	❒	❒	❒	❒

11. Have you filed a patent since establishment? ❒ *Yes* ❒ *No*
    If Yes:
    - What (broad) percentage of its patent portfolio is actively used by your firm? |__|__|__| %
    - Total number of patents used in your firm's patents portfolio in the first year: _____
    - Total number of patents used in your firm's patents portfolio in 2001: _____
    - What (broad) percentage of patents granted that are licensed commercially? |__|__|__| %

PART 2 – FINANCING

2.1 Please Complete for Your Firm:

1. Your Current Stage (Life Cycle):
   ❒ *Seed*[1] ❒ *Start-up*[2] ❒ *Early Stage*[3] ❒ *Expansion/Development*[4]
2. Time elapsed between your Current stage and the Previous stage: |__|__| months
3. Did you invest from your personal funds at Seed or Start-up stages? ❒ *Yes* ❒ *No*
   If Yes, please indicate Year: |__|__|__|__| Total Amount (Euro): _____
4. Did you borrow from your friends and/or family at Seed or Start-up stages? ❒ *Yes* ❒ *No*
   If Yes, please indicate Year: |__|__|__|__| Total Amount (Euro): _____

[1] **Seed Stage** includes business concept to be developed, production of a business plan, prototypes and additional research, prior to bringing a product to test-market.
[2] **Start-up Stage** includes development of the company's products and initial marketing. Companies may be in the process of being set-up or may have been trading for a short time, but may not have sold their product commercially.
[3] **Early-Stage** includes initiation of commercial manufacturing and sales in companies that have completed the product development.
[4] **Expansion/Development Stage** includes the growth and expansion of an established company. Additional sources (work force, financing, and space) are required to increase production capacity, marketing, and sales to grow.

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5. Select your **Sources** of Funds for **Each Stage**:	**Seed**	**Start-up**	**Early**	**Expansion**
Personal Savings	❒	❒	❍	❍
Family and Friends	❒	❒	❍	❍
Banks	❒	❒	❍	❍
Grants	❒	❒	❍	❍
Government Loan Guarantee Schemes	❒	❒	❍	❍
Business Angels	❒	❒	❍	❍
Venture Capital	❒	❒	❍	❍
Non-financial Corporations	❒	❒	❍	❍
Parent Company	❒	❒	❍	❍
Public Issues	❒	❒	❍	❍
Other (pls. specify): _____	❒	❒	❍	❍

2.2. I think Bank Financing for a high-tech start-up has difficulties because of: *(Please rate how strongly you **Agree** or **Disagree** with each of the following statements by placing a check mark in the appropriate box).*	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Lack of market information on technology-based product.	❒	❒	❒	❒	❒
2. Lack of our tangible assets for collaterals.	❒	❒	❒	❒	❒
3. Lack of our firm's track record/credit history with the bank.	❒	❒	❒	❒	❒
4. Lack of our firm's entrepreneurial or managerial experience.	❒	❒	❒	❒	❒
5. Poor quality of our application and business plan.	❒	❒	❒	❒	❒
6. Poor evidence of our repayment capacity.	❒	❒	❒	❒	❒
7. Cost of bank financing.	❒	❒	❒	❒	❒
8. Conditions of bank financing.	❒	❒	❒	❒	❒
9. Slow decision-making process, administration, and bureaucracy of banks.	❒	❒	❒	❒	❒
10. Lack of dedicated specialized bank key personnel and units.	❒	❒	❒	❒	❒
11. Limited stimulating government supported loan guarantee programmes.	❒	❒	❒	❒	❒
12. Administration and bureaucracy of government supported programmes.	❒	❒	❒	❒	❒

13. Did you borrow from a bank for your high-tech firm? ❒ *Yes* ❒ *No*
If Yes, please indicate Year: |__|__|__|__| Total Amount (Euro): _____
14. Did you participate in any government bank loan guarantee programmes? ❒ *Yes* ❒ *No*
If Yes, please indicate Year: |__|__|__|__| Amount Covered (Euro): _____
Loan guarantee programme Name(s): _____

2.3. I think Venture Capital (VC) Financing for a high-tech start-up has difficulties because of: *(Please rate how strongly you **Agree** or **Disagree** with each of the following statements by placing a check mark in the appropriate box).*	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Lack of VC firms' interest in early stage investments.	❒	❒	❒	❒	❒
2. Unwillingness of VC firms to provide small amounts of capital.	❒	❒	❒	❒	❒
3. Lack of understanding of technology by many VC firms.	❒	❒	❒	❒	❒
4. Lack of our firm's registered intangible assets (i.e. registered patents).	❒	❒	❒	❒	❒
5. Poor quality of our business plan and presentation to raise VC funds.	❒	❒	❒	❒	❒
6. Lack of our entrepreneurial/managerial skills.	❒	❒	❒	❒	❒
7. Our concerns over "loss of control" in the company.	❒	❒	❒	❒	❒
8. VC firms´ expectations of high rates of return.	❒	❒	❒	❒	❒
9. Due Diligence difficulties faced by VCs.	❒	❒	❒	❒	❒
10. VC firms´ expectations of quick exit routes.	❒	❒	❒	❒	❒
11. Lack of our market information on VC firms.	❒	❒	❒	❒	❒
12. Lack of Belgian VC executives with specific knowledge and skills.	❒	❒	❒	❒	❒
13. Limited public policies to encourage equity participation.	❒	❒	❒	❒	❒
14. Administration and bureaucracy of government supported programmes.	❒	❒	❒	❒	❒

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15. Did you raise any Venture Capital (VC) funds for your high-tech firm? ❒ *Yes* ❒ *No*

If Yes, please complete:

Year	*Amount (Euro)*	*VC Country of Origin*	*Stage (Seed/Start-up/Early/ Expansion)*
⇘|__|__|__|__|	_____	_____	_____
⇘|__|__|__|__|	_____	_____	_____

16. Did you participate in any government supported VC programmes? ❒ *Yes* ❒ *No*

If Yes, please indicate Year: |__|__|__|__| Amount Covered (Euro): _____

VC guarantee programme Name(s): _____

17. Did you employ a full-time finance manager during your VC negotiations? ❒ *Yes* ❒ *No*
18. Did you employ a full-time marketing manager during your VC negotiations? ❒ *Yes* ❒ *No*
19. Did you get involved with any incubator before or during your VC negotiations? ❒ *Yes* ❒ *No*
20. Did you use external management consultancy services during your VC negotiations? ❒ *Yes* ❒ *No*
21. Do any of your participating VC firms own more than 25% of your company? ❒ *Yes* ❒ *No*
22. Do you eventually plan to participate in Management Buy-Outs (MBO)? ❒ *Yes* ❒ *No*
23. Do you eventually plan to participate in an Initial Public Offering (IPO)? ❒ *Yes* ❒ *No*

2.4 I think <u>Business Angel (BA) Financing</u> for a high-tech start-up has difficulties because of: *(Please rate how strongly you **Agree** or **Disagree** with each of the following statements by placing a check mark in the appropriate box).*	**Strongly Agree**	**Agree**	**Neither Agree nor Disagree**	**Disagree**	**Strongly Disagree**
1. Lack of understanding the role of BAs.	❒	❒	❒	❒	❒
2. Lack of technology and industry knowledge of BAs.	❒	❒	❒	❒	❒
3. Limited reliable information on the activities of the BAs.	❒	❒	❒	❒	❒
4. The small size of BA financing markets in Belgium.	❒	❒	❒	❒	❒
5. Lack of Business Angels networks in Belgium.	❒	❒	❒	❒	❒
6. Concerns of Business Angels over high-perceived risks.	❒	❒	❒	❒	❒
7. "Due Diligence" difficulties faced by BAs.	❒	❒	❒	❒	❒
8. Limited exit options for BAs.	❒	❒	❒	❒	❒
9. Lack of professionalism in BA entities.	❒	❒	❒	❒	❒
10. Poor quality of our application and business plan.	❒	❒	❒	❒	❒
11. Cost of our access to commercial and professional infrastructure.	❒	❒	❒	❒	❒
12. Historical misperceptions against private equity investments in Belgium.	❒	❒	❒	❒	❒
13. Limited government policies to promote private investment financing.	❒	❒	❒	❒	❒
14. Administration and bureaucracy of government supported programmes.	❒	❒	❒	❒	❒

15. Did you raise any Business Angel funds for your high-tech firm? ❒ *Yes* ❒ *No*

If Yes, please complete:

Year	*Amount (Euro)*	*BA Country of Origin*	*Stage (Seed/Start-up/Early/ Expansion)*
⇘|__|__|__|__|	_____	_____	_____
⇘|__|__|__|__|	_____	_____	_____

16. Did you participate in any government supported BA programmes? ❒ *Yes* ❒ *No*

If Yes, please indicate Year: |__|__|__|__| Amount Covered (Euro): _____

BA guarantee programme Name(s): _____

17. Did you employ a full-time finance manager during BA negotiations? ❒ *Yes* ❒ *No*
18. Did you employ a full-time marketing manager during your BA negotiations? ❒ *Yes* ❒ *No*
19. Did you get involved with any incubator before or during your BA negotiations? ❒ *Yes* ❒ *No*
20. Did you use external management consultancy services during your BA negotiations? ❒ *Yes* ❒ *No*
21. Do any of your participating BA firms own more than 25% of your company? ❒ *Yes* ❒ *No*

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PART 3 – ENTREPRENEUR **This Part Should be Completed by One of the Founders/Entrepreneurs**

3.1 Entrepreneur:

1. Age: |__|__|
2. Gender: ❒ *Female* ❒ *Male*
3. Marital Status: ❒ *Single* ❒ *Married* ❒ *Separated*
4. Permanent Residence: ❒ *Flanders* ❒ *Wallonia* ❒ *Brussels-Capital*
5. Select the Appropriate Definition for your Establishment
   ❒ *Start-up*[5] ❒ *Corporate Spin-off* ❒ *University spin-off*[6] ❒ *Other:* _____
6. Select the origin of the idea resulted in the establishment of your new firm:
   ❒ *Independent/Personal Research* ❒ *University/Public Research*
   ❒ *Business Experience* ❒ *Business/Corporate Research*
   ❒ *Use of a Technology Exploited Abroad* ❒ *Other (pls.specify):* _____
7. Duration (months) between the genesis of the idea and the new establishment: |__|__| months
8. Select association of founders with each other:
   ❒ *Family* ❒ *Friends* ❒ *Co-workers* ❒ *Suppliers* ❒ *Other(specify):* _____
9. Highest Degree/Diploma obtained:
   ❒ *Higher education less than 3 years* ❒ *Ph.D./Doctorate*
   ❒ *University* ❒ *Post Doctorate*
   ❒ *Masters* ❒ *Other (pls.specify):* _____
10. Name of the Institute of the Highest Degree obtained: _____
11. Field of Study/Education:
    ❒ *Physics/Chemistry/Biology* ❒ *Electrical/Electronics/Technology Engineering*
    ❒ *Other Engineering* ❒ *Mathematics/Informatics*
    ❒ *Management/Business/Economics* ❒ *Medicine/Veterinary Sciences/Pharmaceutical*
    ❒ *Agriculture* ❒ *Other (pls.specify):* _____
12. Have you followed any entrepreneurship skills courses? ❒ *Yes* ❒ *No*
    If Yes, please indicate Year: |__|__|__|__| Name: _____
13. Does your Father have a Higher Education/University degree? ❒ *Yes* ❒ *No*
14. Profession of Father:
    ❒ *Entrepreneur* ❒ *Self-Employed* ❒ *Farmer*
    ❒ *Worker/Employee* ❒ *Academic/Teaching* ❒ *Consulting*
    ❒ *Government/Public Service* ❒ *Corporate- Management* ❒ *Other:* _____
15. Does your Mother have a Higher Education/University degree? ❒ *Yes* ❒ *No*
16. Profession of Mother:
    ❒ *Entrepreneur* ❒ *Self-Employed* ❒ *Farmer*
    ❒ *Worker/Employee* ❒ *Academic/Teaching* ❒ *Consulting*
    ❒ *Government/Public Service* ❒ *Corporate- Management* ❒ *Other:* _____
17. Total years of employment before entrepreneurship: ❒ *0* ❒ *1 – 3* ❒ *4 – 6* ❒ *More than 6*
18. Former Employment, please select: ❒ *Full-time* ❒ *Part-time* ❒ *Self-Employed*
19. Field of Activity before entrepreneurship:
    ❒ *Manufacturing* ❒ *Research & Development* ❒ *Marketing & Sales* ❒ *Distribution*
    ❒ *Consulting* ❒ *Finance & Accounting* ❒ *Public Relations* ❒ *Teaching*
    ❒ *General Management* ❒ *Other (pls.specify):* _____
20. Last Position before entrepreneurship:
    ❒ *Board Member* ❒ *Shareholder/Partner* ❒ *Senior Manager* ❒ *Academic personnel*
    ❒ *University/ Research Centre Researcher* ❒ *Corporate R&D* ❒ *Analyst/Consultant*
    ❒ *Employee* ❒ *Other (pls.specify):* _____
21. Number of employees managed before entrepreneurship:
    ❒ *Less than 10* ❒ *11 – 50* ❒ *51 – 100* ❒ *101 – 250* ❒ *More than 250*

[5] A **Start-up** company refers to a fully independent new company.
[6] A **Spin-off** company is an incorporated commercial entity that derives a significant portion of its commercial activities from the application or use of a technology and/or know-how developed by or during a research program within a firm or university.

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3.2. I think Belgium offers entrepreneurial opportunities for high tech start-ups because of: *(Please rate how strongly you **Agree** or **Disagree** with each of the following statements by placing a check mark in the appropriate box).*	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
1. Developed transportation networks.	❒	❒	❒	❒	❒
2. Developed utilities.	❒	❒	❒	❒	❒
3. Cost of utilities.	❒	❒	❒	❒	❒
4. Developed communication network.	❒	❒	❒	❒	❒
5. Cost of communications.	❒	❒	❒	❒	❒
6. Availability of commercial and professional networks.	❒	❒	❒	❒	❒
7. Cost of commercial and professional networks.	❒	❒	❒	❒	❒
8. Availability of specialized business analysts for high-tech development.	❒	❒	❒	❒	❒
9. Multilingual and multicultural people.	❒	❒	❒	❒	❒
10. Personal income tax system.	❒	❒	❒	❒	❒
11. Corporate tax system.	❒	❒	❒	❒	❒
12. Social security and welfare system.	❒	❒	❒	❒	❒
13. Administration of public departments/agencies.	❒	❒	❒	❒	❒
14. Government & public policies.	❒	❒	❒	❒	❒
15. Government/public funds available for Research & Development.	❒	❒	❒	❒	❒
16. Technology Regions/Science Parks.	❒	❒	❒	❒	❒
17. Administration of Intellectual Property Rights, patents.	❒	❒	❒	❒	❒
18. Cost of registration of Intellectual Property Rights, patents.	❒	❒	❒	❒	❒
19. Number of Science and Technology graduates.	❒	❒	❒	❒	❒
20. Transfers between universities/public labs and industries.	❒	❒	❒	❒	❒
21. Technology incubators.	❒	❒	❒	❒	❒
22. Networks among industries.	❒	❒	❒	❒	❒
23. Applied research at the higher education institutes.	❒	❒	❒	❒	❒
24. Research & Development at industry level.	❒	❒	❒	❒	❒
3.3. I consider that my company is a high tech firm and:					
1. I perceive myself having entrepreneurial abilities.	❒	❒	❒	❒	❒
2. My main motivation to create my own company is to develop an idea.	❒	❒	❒	❒	❒
3. My main motivation to create my own company is to be my own boss.	❒	❒	❒	❒	❒
4. My main motivation to create my own company is to earn more money.	❒	❒	❒	❒	❒
5. My main motivation to create my own company is to find a professional activity.	❒	❒	❒	❒	❒
6. My main motivation to create my own company is the attraction for the risk.	❒	❒	❒	❒	❒
7. Starting up a new establishment is a nice experience and I'm ready to do it again.	❒	❒	❒	❒	❒
3.4. My objectives at Early Development Stage of my high tech firm are:					
1. Improve our existing products/services.	❒	❒	❒	❒	❒
2. Improve our existing processes.	❒	❒	❒	❒	❒
3. Develop additional new products.	❒	❒	❒	❒	❒
4. Develop additional new processes.	❒	❒	❒	❒	❒
5. Develop additional new services.	❒	❒	❒	❒	❒
6. Change/improve organisational structure.	❒	❒	❒	❒	❒
7. Change/improve management information systems.	❒	❒	❒	❒	❒
8. Train/educate workforce.	❒	❒	❒	❒	❒
9. Eliminate brain drain from our workforce.	❒	❒	❒	❒	❒

THANK YOU!

Prof. Bruno VAN POTTELSBERGHE
Vice-President of Solvay Business School
Solvay Chair of Innovation

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Research Fellows, Solvay Business School

Survey questionnaire in French

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ENQUETE: TECHNOLOGY-BASED SMALL FIRMS (TBSFS) EN BELGIQUE

Nous voudrions tout d'abord saisir cette occasion pour vous remercier d'accepter de prendre part à cette enquête nationale sur les petites entreprises de haute technologie menée par l'Ecole de Commerce Solvay, ULB.

Les objectifs principaux de cette étude sont de comprendre les déterminants socio-économiques de l'activité entrepreneuriale ainsi que les difficultés de récolte de fonds auxquelles sont confrontées les TBSFs en Belgique. Les recommandations issues de cette étude seront employées pour améliorer nos travaux consultatifs actuels pour le gouvernement belge et diverses agences internationales, dont la Commission Européenne et l'OCDE.

A compléter SVP:

Nom: _____ Entreprise: _____ Fonction: _____

Tel: _____ E-mail: _____ Fax: _____

PARTIE 1 –PROFIL DE L'ENTREPRISE

1.1. Votre entreprise :

1. Adresse: _____ Ville: _____ Code postal: |__|__|__|__|
2. Année de création: |__|__|__|__| Numéro de TVA: |__|__|__| |__|__|__| |__|__|__|
3. Statut légal de votre TBSF à sa création : ❒ *Sprl* ❒ *SA* ❒ *Autre (précisez):* _____
4. Capital social (autorisé) à la création de l'entreprise (x000 Euro):
   ❒ *10– 149* ❒ *150 – 249* ❒ *250 – 350* ❒ *Plus de 350*

5. Principal secteur d'activité	*Production*	*Service*
1. Aérospatial	❒	❍
2. Ordinateur et matériel de bureau	❒	❍
3. Electronique et télécommunication	❒	❍
4. Industrie pharmaceutique	❒	❍
5. Instruments scientifiques	❒	❍
6. Matériel électrique	❒	❍
7. Industrie chimique	❒	❍
8. Matériel non-électrique	❒	❍
9. Véhicule motorisé et autre équipement de transport	❒	❍
10. Autre (précisez): _____	❒	❍

6. Nombre de personnes employées:	*2000*	*2001*	*2002*
Moins de 5	❒	❒	❒
5 – 10	❒	❒	❒
11 – 25	❒	❒	❒
26 – 50	❒	❒	❒
Plus de 50	❒	❒	❒

7. Revenu total des ventes/Chiffre d'affaires (Euro)	*2000*	*2001*	*2002*
Moins de 1.000.000	❒	❒	❒
1.000.000 – 2.999.999	❒	❒	❒
3.000.000 – 4.999.999	❒	❒	❒
5.000.000 – 7.000.000	❒	❒	❒
Plus de 7.000.000	❒	❒	❒

8. Total du Bilan (Euro)	*2000*	*2001*	*2002*
Moins de 1.000.000	❒	❒	❒
1.000.000 – 2.999.999	❒	❒	❒
3.000.000 – 5.000.000	❒	❒	❒
Plus de 5.000.000	❒	❒	❒

9. Nombre d'associés/fondateurs à la création de l'entreprise:
   ❒ *1 - 2* ❒ *3 - 4* ❒ *5 - 6* ❒ *7 - 8* ❒ *Plus de 8*

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10. Nombre d'associés/fondateurs détenant 25% ou plus des parts de l'entreprise à sa création: |__|__|
11. Votre entreprise est-elle une filiale ou branche d'une autre entreprise ? ❒ *Oui* ❒ *Non*
    Si Oui, veuillez indiquer son Nom: _____
12. Pays ou région(s) de l'activité commerciale:
    ❒ *Belgique* ❒ *France* ❒ *U.K.* ❒ *Autre dans l'UE* ❒ *USA* ❒ *Reste du Monde*
13. Votre entreprise effectue des activités de R&D ? ❒ *Oui* ❒ *Non*
14. Votre entreprise collabore en R&D avec l'enseignement supérieur/universitaire belge ? ❒ *Oui* ❒ *Non*
15. Votre entreprise collabore en R&D avec un centre de recherche public belge ? ❒ *Oui* ❒ *Non*
16. Votre entreprise utilise des subsides publics pour la recherche ? ❒ *Oui* ❒ *Non*
17. Votre entreprise bénéficie de crédits d'impôt pour la R&D ? ❒ *Oui* ❒ *Non*
18. Pourcentage (approximatif) de votre budget dépensé en R&D : |__|__|__| %
19. Pourcentage (approximatif) de projets R&D exploités commercialement dans votre production : |__|__|__| %

1.2. Nous ne <u>brevetons</u> pas systématiquement nos inventions parce que : *Pour chacune des affirmations ci-dessous, indiquez votre **Accord** ou **Désaccord** en plaçant un "√" dans la colonne appropriée.*	**Totalement d'accord**	**D'accord**	**Ni d'accord, ni pas d'accord**	**Pas d'accord**	**Pas du tout d'accord**
1. Coût de dépôt élevé.	❒	❒	❒	❒	❒
2. Coût de protection élevé.	❒	❒	❒	❒	❒
3. Protection non efficace à cause du manque de confiance dans le système.	❒	❒	❒	❒	❒
4. Secret plus efficace.	❒	❒	❒	❒	❒
5. Avance sur le marché plus efficace.	❒	❒	❒	❒	❒
6. Cycle de vie des produits court.	❒	❒	❒	❒	❒
7. Divulgation des inventions risquée.	❒	❒	❒	❒	❒
8. Impossibilité d'empêcher d'autres firmes de copier la technologie.	❒	❒	❒	❒	❒
9. Savoir-faire et information sur la procédure de dépôt de brevets non connus.	❒	❒	❒	❒	❒
10. Administration lente.	❒	❒	❒	❒	❒

11. Votre entreprise a déposé au moins un brevet depuis sa création ? ❒ *Oui* ❒ *Non*
    Si Oui:
    - Pourcentage (approximatif) de votre portefeuille de brevets activement utilisé par votre entreprise? |__|__|__| %
    - Nombre total de brevets utilisés dans votre portefeuille la première année: _____
    - Nombre total de brevets utilisés dans votre portefeuille en 2001: _____
    - Pourcentage (approximatif) de brevets octroyés qui sont licenciés commercialement ? |__|__|__|%

PARTIE 2 - FINANCEMENT

2.1. Veuillez compléter pour votre entreprise :

1. Etape actuelle de votre développement (cycle de vie) :
   ❒ *Seed*[1] ❒ *Start-up*[2] ❒ *Early Stage*[3] ❒ *Expansion / Development*[4]
2. Temps écoulé entre l'étape actuelle dans votre cycle de vie et l'étape précédente : |__|__| mois
3. Avez-vous investi des fonds personnels lors de l'étape 'Seed' ou 'Start-up'? ❒ *Oui* ❒ *Non*
   Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____
4. Avez-vous emprunté à des amis ou à votre famille lors de l'étape 'Seed' ou 'Start-up' ? ❒ *Oui* ❒ *Non*
   Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____

[1] L'étape « SEED » comprend le concept commercial à développer, la création d'un business plan, le prototype et la recherche additionnelle avant de tester le produit sur le marché.
[2] L'étape « Start Up » comprend le développement des produits et le marketing de départ. Les entreprises peuvent être sur le point de s'établir ou ont commencé à réaliser depuis peu des transactions mais n'ont toujours pas commencé une activité commerciale.
[3] L'étape « Early Stage » comprend le début de la production commerciale et de la vente par une entreprise qui a terminé l'étape du développement de produits mais n'a peut-être pas encore généré de profits.
[4] L'étape « Expansion/Development » comprend la croissance et l'expansion de l'entreprise créée. Des sources additionnelles de personnel, de financement, d'espace sont requises pour augmenter les capacités de production, de marketing et de ventes.

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5. Sélectionnez vos **Sources** de fonds pour **chaque étape**:	**Seed**	**Start-up**	**Early**	**Expansion**
Fonds personnels	❒	❒	❍	❍
Fonds familiaux et d'amis	❒	❒	❍	❍
Banques	❒	❒	❍	❍
Subventions	❒	❒	❍	❍
Programmes publics de garanties bancaires	❒	❒	❍	❍
Business Angels	❒	❒	❍	❍
Venture Capital	❒	❒	❍	❍
Entreprises non financières	❒	❒	❍	❍
Maison Mère (Parent Company)	❒	❒	❍	❍
Bourse (Public Issue)	❒	❒	❍	❍
Autres (spécifiez): _____	❒	❒	❍	❍

2.2. Je pense que le financement bancaire pour une start-up high-tech connaît quelques difficultés à cause du: *Pour chacune des affirmations ci-dessous, indiquez votre **Accord** ou **Désaccord** en plaçant un "√" dans la colonne appropriée.*	Totalement d'accord	D'accord	Ni d'accord, ni pas d'accord	Pas d'accord	Pas du tout d'accord
1. Manque d'information du marché concernant les produits/processus technologiques.	❒	❒	❒	❒	❒
2. Manque de nos actifs tangibles pour les garanties.	❒	❒	❒	❒	❒
3. Manque d'un historique de crédit de notre entreprise avec une banque.	❒	❒	❒	❒	❒
4. Manque d'expérience managériale ou entrepreneuriale de notre entreprise.	❒	❒	❒	❒	❒
5. Faible qualité de notre demande et business plan.	❒	❒	❒	❒	❒
6. Faible évidence de notre capacité à rembourser.	❒	❒	❒	❒	❒
7. Coût du financement bancaire.	❒	❒	❒	❒	❒
8. Conditions de crédits bancaires.	❒	❒	❒	❒	❒
9. Lenteur des processus de décisions et de l'administration dans les banques.	❒	❒	❒	❒	❒
10. Manque de personnel et d'unités spécialisées pour les entreprises.	❒	❒	❒	❒	❒
11. Politiques publiques limitées pour promouvoir le financement bancaire des firmes.	❒	❒	❒	❒	❒
12. Administration et bureaucratie des programmes publics.	❒	❒	❒	❒	❒

13. Avez-vous emprunté à une banque pour votre entreprise high-tech? ❒ Oui ❒ Non
Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____
14. Avez-vous pris part à des programmes publics de garanties bancaires ? ❒ Oui ❒ Non
Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____
Nom(s) de ces programmes de garanties d'emprunts: _____

2.3. Je pense que le financement par Venture Capital (VC) pour une start-up high-tech connaît quelques difficultés à cause du: *Pour chacune des affirmations ci-dessous, indiquez votre **Accord** ou **Désaccord** en plaçant un "√" dans la colonne appropriée.*	Totalement d'accord	D'accord	Ni d'accord, ni pas d'accord	Pas d'accord	Pas du tout d'accord
1. Manque d'intérêt des VC dans les étapes initiales de développement d'une TBSF.	❒	❒	❒	❒	❒
2. Refus des VC d'investir de faibles montants de capitaux.	❒	❒	❒	❒	❒
3. Manque de compréhension des technologies par les VC.	❒	❒	❒	❒	❒
4. Manque d'actifs intangibles enregistrés par notre entreprise (i.e. brevets déposés).	❒	❒	❒	❒	❒
5. Faible qualité du business plan et de notre présentation pour lever des fonds de VC.	❒	❒	❒	❒	❒
6. Manque d'historique des compétences entrepreneuriales et managériales.	❒	❒	❒	❒	❒
7. Notre inquiétude concernant la « perte de contrôle ».	❒	❒	❒	❒	❒
8. L'espérance par les VC d'une haute rentabilité.	❒	❒	❒	❒	❒
9. Difficultés de 'Due Diligence' rencontrées par les VC.	❒	❒	❒	❒	❒
10. L'espérance des VC d'une possibilité de sortie rapide.	❒	❒	❒	❒	❒
11. Manque d'information de notre part sur les VC.	❒	❒	❒	❒	❒
12. Manque de connaissances spécifiques et capacités des gestionnaires des VC belges.	❒	❒	❒	❒	❒
13. Politiques publiques d'encouragement de participation en capital limitées.	❒	❒	❒	❒	❒
14. Administration et bureaucratie des programmes publics.	❒	❒	❒	❒	❒

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15. Avez-vous levé des fonds par Venture Capital pour votre Start-up high-tech ? ❒ *Oui* ❒ *Non*

Si Oui, veuillez compléter :

Année	*Montant (Euro)*	*Pays d'origine du VC*	*Etape (Seed/Start-up/Early/ Expansion)*
|__|__|__|__|	_____	_____	_____
|__|__|__|__|	_____	_____	_____

16. Avez-vous pris part à un programme public de garantie de VC? ❒ *Oui* ❒ *Non*

Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____

Nom(s) de ces programmes de garanties d'emprunts: _____

17. Avez-vous employé un directeur financier temps plein lors de vos négociations du VC ? ❒ *Oui* ❒ *Non*
18. Avez-vous employé un directeur du marketing temps plein lors de vos négociations du VC ? ❒ *Oui* ❒ *Non*
19. Avez-vous travaillé avec un incubateur pendant vos contacts avec un VC ? ❒ *Oui* ❒ *Non*
20. Avez-vous travaillé avec un consultant en management pendant vos contacts avec un VC ? ❒ *Oui* ❒ *Non*
21. Est-ce qu'un de vos VCs possède plus de 25% de votre entreprise ? ❒ *Oui* ❒ *Non*
22. Planifiez-vous de finalement participer à un Management Buy-Outs (MBO) ? ❒ *Oui* ❒ *Non*
23. Anticipez-vous de finalement vous faire coter en bourse, Initial Public Offering (IPO) ? ❒ *Oui* ❒ *Non*

2.4. Je pense que le financement par Business Angel (BA) pour une start-up high-tech connaît quelques difficultés à cause du: *Pour chacune des affirmations ci-dessous, indiquez votre **Accord** ou **Désaccord** en plaçant un "√" dans la colonne appropriée.*	**Totalement d'accord**	**D'accord**	**Ni d'accord, ni pas d'accord**	**Pas d'accord**	**Pas du tout d'accord**
1. Manque de compréhension du rôle des Business Angels (BA).	❒	❒	❒	❒	❒
2. Manque de connaissance par les BA de la technologie et du secteur.	❒	❒	❒	❒	❒
3. Limitation des informations sûres concernant les activités des BA.	❒	❒	❒	❒	❒
4. Faible taille du marché informel en Belgique.	❒	❒	❒	❒	❒
5. Manque de réseaux de BA en Belgique.	❒	❒	❒	❒	❒
6. Inquiétude des BA à propos de la perception du haut niveau de risque.	❒	❒	❒	❒	❒
7. Difficulté de « Due Diligence » des BAs.	❒	❒	❒	❒	❒
8. Limitation des opportunités de sortie des BA.	❒	❒	❒	❒	❒
9. Manque de professionnalisme des entités de BA.	❒	❒	❒	❒	❒
10. Faible qualité de notre demande et de notre business plan	❒	❒	❒	❒	❒
11. Coût d'accès aux infrastructures commerciales et professionnelles.	❒	❒	❒	❒	❒
12. Mauvaise perception historique des investissements privés en capitaux en Belgique.	❒	❒	❒	❒	❒
13. Limitation des politiques publiques de promotion de l'investissement privé.	❒	❒	❒	❒	❒
14. Administration et bureaucratie des programmes publics.	❒	❒	❒	❒	❒

15. Avez-vous levé des fonds par Business Angel pour votre Start-up high-tech ? ❒ *Oui* ❒ *Non*

Si Oui, veuillez compléter :

Année	*Montant (Euro)*	*Pays d'origine du BA*	*Etape (Seed/Start-up/Early/ Expansion)*
|__|__|__|__|	_____	_____	_____
|__|__|__|__|	_____	_____	_____

16. Avez-vous pris part à un programme public de garantie de BA? ❒ Oui ❒ Non

Si Oui, indiquez l'année: |__|__|__|__| et le montant total (Euro): _____

Nom(s) de ces programmes de garanties d'emprunts: _____

17. Avez-vous employé un directeur financier temps plein lors de vos négociations du BA ? ❒ Oui ❒ Non
18. Avez-vous employé un directeur du marketing temps plein lors de vos négociations du BA ? ❒ Oui ❒ Non
19. Avez-vous travaillé avec un incubateur pendant vos contacts avec un BA ? ❒ Oui ❒ Non
20. Avez-vous travaillé avec un consultant en management pendant vos contacts avec un BA ? ❒ Oui ❒ Non
21. Est-ce qu'un de vos BAs possède plus de 25% de votre entreprise ? ❒ Oui ❒ Non

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PARTIE 3 – ENTREPRENEUR **Cette partie doit être complétée par un des Fondateurs/Entrepreneurs**

3.1 Les principaux fondateurs/entrepreneurs:

1. Age: |__|__|
2. Sexe: ❒ *Féminin* ❒ *Masculin*
3. Etat civil: ❒ *Célibataire* ❒ *Marié* ❒ *Séparé*
4. Résidence permanente: ❒ *Flandre* ❒ *Wallonie* ❒ *Bruxelles-Capitale*
5. Définition de la nouvelle entité
   ❒ *Start-up*[5] ❒ *Spin-off d'entreprise* ❒ *Spin-off*[6] *universitaire* ❒ *Autre (Précisez):* _____
6. Origine de l'idée résultant en la fondation de la nouvelle entité
   ❒ *Indépendant/Recherche personnelle* ❒ *Université/Recherche publique*
   ❒ *Expérience des affaires* ❒ *Recherche privée*
   ❒ *Technologie exploitée à l'étranger* ❒ *Autre (Précisez):* _____
7. Temps entre la naissance de l'idée et la fondation de la nouvelle entité: |__|__| *mois*
8. Lien unissant les fondateurs de la nouvelle entité les uns aux autres:
   ❒ *Famille* ❒ *Amis* ❒ *Collègues* ❒ *Fournisseur* ❒ *Autre (Précisez):* _____
9. Plus haut diplôme obtenu :
   ❒ *Etudes supérieures de moins de 3 ans* ❒ *Doctorat*
   ❒ *Licence universitaire* ❒ *Post Doctorat*
   ❒ *Maîtrise* ❒ *Autre (Précisez):* _____
10. Nom de l'institution du plus haut diplôme obtenu: _____
11. Type d'études :
    ❒ *Physique/Chimie/Biologie* ❒ *Ingénieur en électricité/électronique/technologie*
    ❒ *Ingénieur autre* ❒ *Mathématique/Informatique*
    ❒ *Management/Commerce/Economie* ❒ *Médecine/Sciences vétérinaires/Pharmacie*
    ❒ *Agriculture* ❒ *Autre (Précisez):* _____
12. Avez-vous suivi des cours spécifiques d'entrepreneurship ? ❒ *Oui* ❒ *Non*
    Si Oui, veuillez-en indiquer l'année: |__|__|__|__| Nom: _____
13. Votre père a-t-il un diplôme d'études supérieures/universitaires ? ❒ *Oui* ❒ *Non*
14. Profession du père:
    ❒ *Entrepreneur* ❒ *Indépendant* ❒ *Agriculteur/Eleveur*
    ❒ *Employé* ❒ *Enseignant* ❒ *Consultant*
    ❒ *Service Public/ Gouvernement* ❒ *Manager* ❒ *Autre:* _____
15. Votre mère a-t-elle un diplôme d'études supérieures/universitaires ? ❒ *Oui* ❒ *Non*
16. Profession de la mère:
    ❒ *Entrepreneur* ❒ *Indépendante* ❒ *Agricultrice/Eleveuse*
    ❒ *Employée* ❒ *Enseignante* ❒ *Consultante*
    ❒ *Service Public/ Gouvernement* ❒ *Manager* ❒ *Autre:* _____
17. Nombre total d'années dans un/plusieurs emplois avant d'être entrepreneur:
    ❒ *Pas de précédent emploi* ❒ *1 – 3* ❒ *4 – 6* ❒ *Plus de 6 ans*
18. Précédent emploi : ❒ *Employé temps-plein* ❒ *Employé mi-temps* ❒ *Indépendant*
19. Type d'activité(s) du précédent emploi:
    ❒ *Production* ❒ *Recherche et développement* ❒ *Marketing & Ventes* ❒ *Distribution*
    ❒ *Consultance* ❒ *Finance & Comptabilité* ❒ *Relations publiques* ❒ *Enseignant*
    ❒ *Management général* ❒ *Autre (Précisez):* _____
20. Dernière fonction dans le précédent emploi:
    ❒ *Membre du conseil* ❒ *Actionnaire/Partner* ❒ *Senior Manager* ❒ *Personnel académique*
    ❒ *Chercheur dans une université/centre de recherche* ❒ *Chercheur dans le département de R&D*
    ❒ *Analyste/Consultant* ❒ *Employé* ❒ *Autre:* _____
21. Nombre de subordonnés dans le précédent emploi:
    ❒ *Moins de 10* ❒ *11 – 50* ❒ *51 – 100* ❒ *101 – 250* ❒ *Plus de 250*

[5] Une **Start-up** est définie comme une nouvelle entreprise totalement indépendante.
[6] Une **Spin-off** est une entité commerciale dont une portion significative de ses activités commerciales provient de l'application ou de l'utilisation d'une technologie et/ou d'un savoir-faire développé par ou durant un programme de recherche à l'intérieur d'une entreprise ou d'une université.

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3.2. Je pense que la Belgique offre des opportunités entrepreneuriales pour une start-up high-tech à cause du (des): *Pour chacune des affirmations ci-dessous, indiquez votre **Accord** ou **Désaccord** en plaçant un "√" dans la colonne appropriée.*	Totalement d'accord	D'accord	Ni d'accord, ni pas d'accord	Pas d'accord	Pas du tout d'accord
1. Réseau de transport développé.	❒	❒	❒	❒	❒
2. Facilités en terme d'électricité, de fourniture et d'évacuation d'eau, …	❒	❒	❒	❒	❒
3. Coût des facilités en terme d'électricité, de fourniture et d'évacuation d'eau,…	❒	❒	❒	❒	❒
4. Réseau de communications développé.	❒	❒	❒	❒	❒
5. Coût des communications.	❒	❒	❒	❒	❒
6. Disponibilité de réseaux commerciaux et professionnels.	❒	❒	❒	❒	❒
7. Coût des réseaux commerciaux et professionnels.	❒	❒	❒	❒	❒
8. Disponibilité d'analystes spécialisés dans le développement en high-tech.	❒	❒	❒	❒	❒
9. Environnement multilingue et multiculturel.	❒	❒	❒	❒	❒
10. Système fiscal sur les revenus personnels.	❒	❒	❒	❒	❒
11. Système fiscal des entreprises.	❒	❒	❒	❒	❒
12. Système de sécurité sociale et de santé.	❒	❒	❒	❒	❒
13. Administrations et agences publiques.	❒	❒	❒	❒	❒
14. Politiques publiques.	❒	❒	❒	❒	❒
15. Disponibilité de fonds publics pour la R&D.	❒	❒	❒	❒	❒
16. Parcs scientifiques / Pôles technologiques.	❒	❒	❒	❒	❒
17. Administration de la propriété intellectuelle (brevets).	❒	❒	❒	❒	❒
18. Coût de la propriété intellectuelle, du dépôt de brevets.	❒	❒	❒	❒	❒
19. Nombre de diplômés en sciences et technologie.	❒	❒	❒	❒	❒
20. Transfert entre universités/laboratoires publics et le secteur privé.	❒	❒	❒	❒	❒
21. Incubateurs technologiques.	❒	❒	❒	❒	❒
22. Networking d'entreprises appartenant à un même secteur d'activité.	❒	❒	❒	❒	❒
23. Recherche appliquée dans les institutions d'enseignement supérieur.	❒	❒	❒	❒	❒
24. R&D au niveau sectoriel.	❒	❒	❒	❒	❒
3.3. Je considère que mon entreprise est une petite entreprise de haute technologie (TBSF) et:					
1. Je pense avoir des capacités entrepreneuriales.	❒	❒	❒	❒	❒
2. Ma principale motivation à créer ma propre entreprise est de développer une idée.	❒	❒	❒	❒	❒
3. Ma principale motivation à créer ma propre entreprise est d'être mon propre patron.	❒	❒	❒	❒	❒
4. Ma principale motivation à créer ma propre entreprise est de gagner plus d'argent.	❒	❒	❒	❒	❒
5. Ma principale motivation à créer ma propre entreprise est de trouver une activité professionnelle.	❒	❒	❒	❒	❒
6. Ma principale motivation à créer ma propre entreprise est l'attrait du risque.	❒	❒	❒	❒	❒
7. Créer une nouvelle entreprise est une bonne expérience et je suis prêt(e) à le refaire.	❒	❒	❒	❒	❒
3.4 Mes objectifs au début du développement de mon entreprise high-tech sont:					
1. Améliorer nos produits/services existants.	❒	❒	❒	❒	❒
2. Améliorer nos processus existants.	❒	❒	❒	❒	❒
3. Développer de nouveaux produits.	❒	❒	❒	❒	❒
4. Développer de nouveaux processus.	❒	❒	❒	❒	❒
5. Développer de nouveaux services.	❒	❒	❒	❒	❒
6. Changer/améliorer la structure organisationnelle.	❒	❒	❒	❒	❒
7. Changer/améliorer les systèmes de gestion intégrée.	❒	❒	❒	❒	❒
8. Former la main-d'œuvre.	❒	❒	❒	❒	❒
9. Endiguer la fuite des cerveaux au sein de notre main-d'œuvre.	❒	❒	❒	❒	❒

MERCI DE VOTRE COLLABORATION !

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Survey questionnaire in Flemish

VERTROUWELIJK

ONDERZOEK: TECHNOLOGY-BASED SMALL FIRMS (TBSFS) IN BELGIË

Vooreerst wil ik van de mogelijkheid gebruik maken om U te bedanken om deel te nemen aan dit nationaal onderzoek naar Technology-Based Small Firms (TBSFs), georganiseerd door de Solvay Business School, ULB.

Het voornaamste doel van deze studie is inzicht te krijgen in de belangrijkste socio-economische factoren die het ondernemersschap bepalen en om inzicht te krijgen in welke mate TBSFs moeilijkheden kennen bij het zoeken naar kapitaal in België. De resultaten van deze studie zullen gebruik worden om onze opdrachten voor de verschillende Belgische regeringen en voor internationale organisaties zoals de Europese Commissie en de OECD te optimaliseren.

Gelieve in te vullen:
Naam: _____ Bedrijf: _____ Functie: _____
Tel: _____ E-mail: _____ Fax: _____

DEEL 1 – BEDRIJFSPROFIEL

1.1 Gelieve de volgende vragen over uw bedrijf in te vullen:

1. Adres: _____ Gemeente: _____ Postcode: |__|__|__|__|
2. Jaar van oprichting: |__|__|__|__| BTW nummer: |__|__|__| |__|__|__| |__|__|__|
3. Onder welke rechtsvorm opereert uw bedrijf: ❒ *Bvba* ❒ *NV* ❒ *Andere:*_____
4. Bedrijfskapitaal bij de oprichting (x000 Euro):
   ❒ *10 – 149* ❒ *150 – 249* ❒ *250 – 350* ❒ *Meer dan 350*
5. Wat is jullie voornaamste activiteitensector

	Fabricatie	*Diensten*
1. Ruimtevaart	❒	❍
2. Computers en kantoormachines	❒	❍
3. Elektronica en telecommunicatie	❒	❍
4. Farmaceutische nijverheid	❒	❍
5. Wetenschappelijke instrumenten	❒	❍
6. Elektrische machines en apparaten	❒	❍
7. Chemische nijverheid	❒	❍
8. Niet-elektrische machines en apparaten	❒	❍
9. Motorvoertuigen en ander transportmateriaal	❒	❍
10. Andere (glv te specifieren):_____	❒	❍

6. Aantal werknemers:

	2000	*2001*	*2002*
Minder dan 5	❒	❒	❒
5 – 10	❒	❒	❒
11 – 25	❒	❒	❒
26 – 50	❒	❒	❒
Meer dan 50	❒	❒	❒

7. Totale Omzet/Verkoop (Euro)

	2000	*2001*	*2002*
Minder dan 1.000.000	❒	❒	❒
1.000.000 – 2.999.999	❒	❒	❒
3.000.000 – 4.999.999	❒	❒	❒
5.000.000 – 7.000.000	❒	❒	❒
Meer dan 7.000.000	❒	❒	❒

8. Balanstotaal /Totaal van de Activa (Euro)

	2000	*2001*	*2002*
Minder dan 1.000.000	❒	❒	❒
1.000.000 –2.999.999	❒	❒	❒
3.000.000 –5.000.000	❒	❒	❒
Meer dan 5.000.000	❒	❒	❒

9. Hoeveel oprichters/partners waren er bij de oprichting van het bedrijf:
   ❒ *1 – 2* ❒ *3 – 4* ❒ *5 – 6* ❒ *7 – 8* ❒ *Meer dan 8*

VERTROUWELIJK

10. Hoeveel oprichters/partners bezaten 25% of meer van het kapitaal bij de oprichting: |__|__|
11. Is uw bedrijf een dochteronderneming of een filiaal van een ander bedrijf: ❒ *Ja* ❒ *Neen*
    Indien ja, welk bedrijf: _____
12. In welke landen/regio's bent u actief:
    ❒ *België* ❒ *Frankrijk* ❒ *V.K.* ❒ *Andere EU* ❒ *USA* ❒ *Rest van de wereld*
13. Voert uw bedrijf R&D activiteiten uit ❒ *Ja* ❒ *Neen*
14. Werkt uw bedrijf samen met Belgische hogescholen/universiteiten ivm R&D ❒ *Ja* ❒ *Neen*
15. Werkt uw bedrijf samen met Belgische publieke research centra ivm R&D ❒ *Ja* ❒ *Neen*
16. Ontvangt uw bedrijf overheids/publieke R&D subsidies ❒ *Ja* ❒ *Neen*
17. Ontvangt uw bedrijf belastingskredieten voor R&D ❒ *Ja* ❒ *Neen*
18. Welk (benaderend) percentage van uw budget wordt aan R&D besteed |__|__|__| %
19. Welk percentage van R&D projecten wordt commercieel benut via eigen productie: |__|__|__| %

1.2. Wij <u>patenteren</u> onze uitvindingen niet systematisch omdat: *Duid doormiddel van een "√" aan tot op welke hoogte volgende uitspraken van toepassing zijn.*	**Volledig akkoord**	**Akkoord**	**Noch akkoord Noch oneens**	**Oneens**	**Volledig oneens**
1. De kosten voor het deponeren te hoog zijn.	❒	❒	❒	❒	❒
2. De beschermingskosten te hoog zijn.	❒	❒	❒	❒	❒
3. Er inefficiënte bescherming en gebrek aan vertrouwen in het systeem is.	❒	❒	❒	❒	❒
4. Geheimhouding efficiënter is.	❒	❒	❒	❒	❒
5. Voorsprong op de markt efficiënter is.	❒	❒	❒	❒	❒
6. Ons product een te korte levenscyclus heeft.	❒	❒	❒	❒	❒
7. Het vrijgeven van onze uitvinding te riskant is.	❒	❒	❒	❒	❒
8. Het onmogelijk is te voorkomen dat anderen de technologie kopiëren.	❒	❒	❒	❒	❒
9. We geen informatie of geen know-how over het patenteringsproces hebben.	❒	❒	❒	❒	❒
10. De administratie te traag is.	❒	❒	❒	❒	❒

11. Heeft uw bedrijf ooit een patent gedeponeerd sinds haar oprichting? ❒ *Ja* ❒ *Neen*
    Indien U ja antwoordde, gelieve de volgende vragen in te vullen:
- Welk percentage van jullie patentportfolio wordt actief gebruikt door jullie bedrijf? |__|__|__| %
- Hoeveel patenten uit jullie portfolio werden gebruikt gedurende het eerste jaar van jullie bedrijf: _____
- Hoeveel patenten uit jullie portfolio werden gebruikt in jullie bedrijf anno 2001: _____
- Welk percentage van de toegekende patenten wordt commercieel in licentie gegeven? |__|__|__| %

PART 2 - FINANCIERING

2.1 Gelieve de volgende vragen in te vullen betreffende uw bedrijf:

1. Huidige FASE (Levenscyclus):
   ❒ *Seed*[1] ❒ *Start-up*[2] ❒ *Early Stage*[3] ❒ *Expansion / Development*[4]
2. Tijdsduur (uitgedrukt in maanden) tussen de huidige fase en de vorige fase |__|__| maanden
3. Investeerde U eigen kapitaal gedurende de Seed of Start-up fase? ❒ *Ja* ❒ *Neen*
   Indien ja, in welk jaar: |__|__|__|__| Totaal Bedrag (Euro): _____
4. Leende U kapitaal van vrienden en/of familie gedurende de Seed of Start-up fase? ❒ *Ja* ❒ *Neen*
   Indien ja, in welk jaar: |__|__|__|__| Totaal Bedrag (Euro): _____

[1] **Seed Stage** omvat de ontwikkeling van het business concept, het maken van een business plan, prototypes en bijkomend onderzoek, alvorens een produkt op een testmarkt te lanceren.
[2] **Start-up** fase omvat de ontwikkeling van bedrijfsprodukten en de initiële marketing. Bedrijven zijn mogelijk in de oprichtingsprocedure of hebben mogelijk sinds kort enkele transacties gedaan zonder echt commercieel actief te zijn.
[3] **Early-Stage** omvat het begin van commerciële productie en verkoop zonder dat het bedrijf noodzakelijkerwijs winstgevend is.
[4] **Expansion/Development Stage** omvat de groei en expansie van bevestigde bedrijven. Bijkomende middelen (personeel, financiering, ruimte) zijn noodzakelijk om de productiecapaciteit, marketing, verkoop en groei te verhogen.

VERTROUWELIJK

5. Gelieve uw financieringsmiddelen **gedurende iedere fase** aan te duiden:

	Seed	Start-up	Early	Expansion
Persoonlijke financiering	❒	❒	❍	❍
Familie en vrienden	❒	❒	❍	❍
Banken	❒	❒	❍	❍
Subsidies	❒	❒	❍	❍
Garantieprogramma's van de overheid	❒	❒	❍	❍
Business Angels	❒	❒	❍	❍
Venture Capital	❒	❒	❍	❍
Niet-financiële ondernemingen	❒	❒	❍	❍
Moederbedrijf	❒	❒	❍	❍
Publieke financiering (Aandelen of Obligaties)	❒	❒	❍	❍
Andere (glv te specifieren): _____	❒	❒	❍	❍

2.2. Ik vind dat <u>bank financiering</u> voor een high-tech start-up belemmerd is door: *Duid door middel van een "√" aan tot op welke hoogte de volgende uitspraken van toepassing zijn.*	Volledig akkoord	Akkoord	Noch akkoord Noch oneens	Oneens	Volledig oneens
1. Gebrek aan marktinformatie over technologische producten/processen	❒	❒	❒	❒	❒
2. Gebrek aan onderpanden/waarborgen	❒	❒	❒	❒	❒
3. Gebrek aan historiek/aanwezigheid op de markt betreffende uw TBSF	❒	❒	❒	❒	❒
4. Gebrek in ons bedrijf aan ervaring in management en in ondernemen.	❒	❒	❒	❒	❒
5. Gebrekkige kwaliteit van onze aanvraag	❒	❒	❒	❒	❒
6. Gebrek aan zekerheid over onze terugbetalingscapaciteit.	❒	❒	❒	❒	❒
7. Kosten van bankfinanciering	❒	❒	❒	❒	❒
8. De voorwaarden van de bankkredieten	❒	❒	❒	❒	❒
9. Trage besluitvorming, administratie en bureaucratie in banken	❒	❒	❒	❒	❒
10. Gebrek aan gespecialiseerde eenheden en bankpersoneel voor bedrijven	❒	❒	❒	❒	❒
11. Beperkte bankgarantieprogramma's van de overheid	❒	❒	❒	❒	❒
12. Administratie en bureaucratie van de overheidsprogramma's	❒	❒	❒	❒	❒

13. Verkreeg U bankleningen voor uw high-tech bedrijf? ❒ *Ja* ❒ *Neen*
Indien zo, in welk jaar: |__|__|__|__| en welk bedrag (Euro): _____
14. Heeft U deelgenomen aan een bankgarantieprogramma van de overheid? ❒ *Ja* ❒ *Neen*
Indien zo, in welk jaar: |__|__|__|__| en welk bedrag (Euro): _____
Wat is de naam van dat bankgarantieprogramma:_____

2.3. Ik vind dat <u>financiering door Venture Capitalists (VC)</u> voor een high-tech start-up belemmerd is door: *Duid door middel van een "√" aan tot op welke hoogte de volgende uitspraken van toepassing zijn.*	Volledig akkoord	Akkoord	Noch akkoord Noch oneens	Oneens	Volledig oneens
1. Gebrek aan interesse van venture kapitalisten in early stage investeringen	❒	❒	❒	❒	❒
2. Gebrek aan bereidheid van venture kapitalisten om kleine bedragen te investeren	❒	❒	❒	❒	❒
3. Het feit dat de technologie niet begrepen is door de venture kapitalisten	❒	❒	❒	❒	❒
4. Gebrek aan geregistreerde immateriële activa (bv.gedeponeerde patenten) in ons bedrijf	❒	❒	❒	❒	❒
5. Onvoldoende kwaliteit van ons business plan en onze presentatie bij de VC	❒	❒	❒	❒	❒
6. Gebrek aan historiek van onze management/ondernemersvaardigheden	❒	❒	❒	❒	❒
7. Onze bezorgdheid om controle over het bedrijf te verliezen	❒	❒	❒	❒	❒
8. Verwachtingen van hoge opbrengsten door de VC voor hun investering	❒	❒	❒	❒	❒
9. Problemen voor een VC om hun "due diligence" uit te voeren.	❒	❒	❒	❒	❒
10. Verwachtingen van de VC van snelle exits	❒	❒	❒	❒	❒
11. Ons gebrek aan informatie over VC's	❒	❒	❒	❒	❒
12. Een gebrek aan Belgische venture kapitalisten met specifieke kennis en vaardigheden	❒	❒	❒	❒	❒
13. Te weinig publieke programma's om venture capital te stimuleren	❒	❒	❒	❒	❒
14. Administratie en bureaucratie van dergelijke overheidsfaciliteiten	❒	❒	❒	❒	❒

VERTROUWELIJK

15. Verkreeg uw high-tech bedrijf financiering van een venture capitalist ? ❒ Ja ❒ Neen

Indien zo, gelieve aan te vullen:

Jaar	*Bedrag (Euro)*	*VC Land van Oorsprong*	*Fase (Seed/Start-up/Early/ Expansion)*
|__|__|__|__|	_____	_____	_____
|__|__|__|__|	_____	_____	_____

16. Heeft u deelgenomen aan VC garantieprogramma's van de overheid? ❒ Ja ❒ Neen

Indien zo, in welk jaar: |__|__|__|__| Totaal bedrag (Euro): _____

Naam van het VC garantieprogramma:_____

17. Was er een full-time financieel manager/directeur in dienst tijdens de VC onderhandelingen? ❒ Ja ❒ Neen
18. Was er een full-time marketing manager/directeur in dienst tijdens de VC onderhandelingen? ❒ Ja ❒ Neen
19. Heeft u samengewerkt met een incubator voor of tijdens de VC onderhandelingen? ❒ Ja ❒ Neen
20. Heeft u samengewerkt met een management consultant voor of tijdens de VC onderhandelingen? ❒ Ja ❒ Neen
21. Bezit een van uw venture kapitalisten meer dan 25% van uw bedrijf? ❒ Ja ❒ Neen
22. Overweegt U om ooit deel te nemen aan een Management Buy-Out (MBO)? ❒ Ja ❒ Neen
23. Verwacht U ooit uw bedrijf op de beurs te laten noteren (IPO)? ❒ Ja ❒ Neen

2.4. Ik vind <u>dat financiering door Business Angels (BA)</u> voor een high-tech start-up belemmerd is door: *Duid door middel van een "√" aan tot op welke hoogte de volgende uitspraken van toepassing zijn.*	**Volledig akkoord**	**Akkoord**	**Noch akkoord Noch oneens**	**Oneens**	**Volledig oneens**
1. Het feit dat de rol van een BA slecht begrepen wordt	❒	❒	❒	❒	❒
2. Gebrek aan kennis van de BA over onze technologie en industrie	❒	❒	❒	❒	❒
3. Beperkte betrouwbare informatie over de aciviteiten van de BA	❒	❒	❒	❒	❒
4. De kleine schaal van de informele markt in België	❒	❒	❒	❒	❒
5. Gebrek aan BA netwerken in België	❒	❒	❒	❒	❒
6. Terughoudendheid van BA omwille van de hoge risico's	❒	❒	❒	❒	❒
7. Problemen voor een BA om hun due diligence uit te voeren	❒	❒	❒	❒	❒
8. Beperkte exit mogelijkeden voor Business Angels	❒	❒	❒	❒	❒
9. Gebrek aan professionalisme bij Business Angels	❒	❒	❒	❒	❒
10. Gebrekkige kwaliteit van onze aanvraag en ons business plan	❒	❒	❒	❒	❒
11. De toegangskosten voor ons bedrijf tot commerciële en profesionele infrastructuur	❒	❒	❒	❒	❒
12. Historische misperceptie in België over privé-investeringen	❒	❒	❒	❒	❒
13. Te weining overheidsprogramma's om privé-investeringen te promoten	❒	❒	❒	❒	❒
14. Administratie en bureaucratie van dergelijke overheidsfaciliteiten	❒	❒	❒	❒	❒

15. Verkreeg uw high-tech bedrijf fondsen van een Business Angel? ❒ Ja ❒ Neen

Indien zo, gelieve aan te vullen:

Jaar	*Bedrag (Euro)*	*BA Land van Oorsprong*	*Fase (Seed/Start-up/Early/ Expansion)*
|__|__|__|__|	_____	_____	_____
|__|__|__|__|	_____	_____	_____

16. Heeft u deelgenomen aan BA garantieprogramma's van de overheid? ❒ Ja ❒ Neen

Indien zo, in welk jaar: |__|__|__|__| Totaal bedrag (Euro): _____

Naam van het BA garantieprogramma's:_____

17. Was er een full-time financieel manager/directeur in dienst tijdens de BA onderhandelingen? ❒ Ja ❒ Neen
18. Was er een full-time marketing manager/directeur in dienst tijdens de BA onderhandelingen? ❒ Ja ❒ Neen
19. Heeft u samengewerkt met een incubator voor of tijdens de BA onderhandelingen? ❒ Ja ❒ Neen
20. Heeft u samengewerkt met een management consultant voor of tijdens de BA onderhandelingen ❒ Ja ❒ Neen
21. Bezit een van uw business angels meer dan 25% van uw bedrijf? ❒ Ja ❒ Neen

VERTROUWELIJK

PART 3 - DE ONDERNEMER **Dit deel dient door een van de oprichters/entrepreneurs ingevuld te worden.**

3.1 Vragen betreffende de voornaamste oprichter/ondernemer:

1. Leeftijd: |__|__|
2. Geslacht: ❒ *Vrouwelijk* ❒ *Mannelijk*
3. Burgelijke stand: ❒ *Alleenstaand* ❒ *Getrouwd* ❒ *Gescheiden*
4. Permanente verblijfplaats: ❒ *Vlaanderen* ❒ *Wallonië* ❒ *Brussel Hoofdstad*
5. Wat is de gepaste definitie van uw bedrijf
   ❒ *Start-up*[5] ❒ *Bedrijfsspin-off* ❒ *University spin-off*[6] ❒ *Andere (glv te specifiëren):*_____
6. Wat was de basis van uw idee dat resulteerde in de oprichting van uw bedrijf
   ❒ *Onafhankelijk/eigen onderzoek* ❒ *Universitair/publiek onderzoek*
   ❒ *Business ervaring* ❒ *Business/bedrijfs onderzoek*
   ❒ *Een in het buitenland geëxploiteerde technology* ❒ *Andere (glv te specifiëren):*_____
7. Hoeveel tijd verliep er tussen de oorsprong van uw idee en de oprichting van uw bedrijf: |__|__| maanden
8. Welke band hebben de oprichters onderling:
   ❒ *Familie* ❒ *Vrienden* ❒ *Medewerkers* ❒ *Leveranciers* ❒ *Andere:* _____
9. Hoogst bereikt diploma
   ❒ *Hogeschool (kort programma 3 jaar)* ❒ *Doctoraat*
   ❒ *Universiteit* ❒ *Postdoctoraat*
   ❒ *Aanvullende master opleiding* ❒ *Andere (glv te specifiëren):*_____
10. Naam van het instituut waar dit diploma behaald werd: _____
11. Domein van de studies/opleiding
    ❒ *Fysica/Chemie/Biologie* ❒ *Electrisch/Electronisch/Technologisch ingenieur*
    ❒ *Ander ingenieur* ❒ *Wiskunde/Informatica*
    ❒ *Management/Business/Economie* ❒ *Geneeskunde/Dierenarts/Farmacie*
    ❒ *Landbouwkunde* ❒ *Andere (glv te specifiëren):*_____
12. Heeft U ooit een vak over entrepreneurschip gevolgd ❒ *Ja* ❒ *Neen*
    Indien zo, in welk jaar: |__|__|__|__| Wat was de naam van het vak:_____
13. Heeft uw vader een hoge school/universitair diploma? ❒ *Ja* ❒ *Neen*
14. Wat is het beroep van uw vader:
    ❒ *Entrepreneur* ❒ *Zelfstandige* ❒ *Landbouwer*
    ❒ *Werknemer* ❒ *Academicus/Leraar* ❒ *Consultant*
    ❒ *Overheidsdiensten* ❒ *Corporate Management* ❒ *Andere:* _____
15. Heeft uw moeder een hoge school/universitair diploma? ❒ *Ja* ❒ *Neen*
16. Wat is het beroep van uw moeder:
    ❒ *Entrepreneur* ❒ *Zelfstandige* ❒ *Landbouwer*
    ❒ *Werknemer* ❒ *Academicus/Leraar* ❒ *Consultant*
    ❒ *Overheidsdiensten* ❒ *Corporate Management* ❒ *Andere:* _____
17. Hoeveel jaren was u al professioneel actief alvorens entrepreneur te worden:
    ❒ *Geen* ❒ *1 – 3* ❒ *4 – 6* ❒ *Meer dan 6 jaar*
18. In uw vorig werk was u: ❒ *Voltijds werknemer* ❒ *Deeltijds werknemer* ❒ *Zelfstandig*
19. In welk domein was u actief alvorens entrepreneur te worden:
    ❒ *Productie* ❒ *Research & Development* ❒ *Marketing & Sales* ❒ *Distributie & Logistiek*
    ❒ *Consulting* ❒ *Finance & Accounting* ❒ *Public Relations & Communicatie*
    ❒ *General Management* ❒ *Lesgeven* ❒ *Andere:*_____
20. Wat was uw laatste betrekking alvorens entrepreneur te worden:
    ❒ *Aandeelhouder/Partner* ❒ *Raad van bestuur* ❒ *Senior Manager*
    ❒ *Onderzoeker aan de universiteit/onderzoek centrum* ❒ *Academisch personneel*
    ❒ *Deel van een R&D departement in een bedrijf* ❒ *Analyst/Consultant*
    ❒ *Werknemer* ❒ *Andere:* _____
21. Voor hoeveel werknemers was u verntwoordelijk alvorens entrepreneur te worden:
    ❒ *Minder dan 10* ❒ *11 – 50* ❒ *51 – 100* ❒ *101 – 250* ❒ *Meer dan 250*

[5] Een **Start-up** is gedefinieerd als een volledig onafhankelijk bedrijf.
[6] Een **Spin-off** is gedefinieerd als een bedrijf waar een groot deel van haar commerciële activiteiten voortvloeien uit de toepassing of het gebruik van een technologie en/of know-how die onwikkeld werd gedurende een research programma van een ander bedrijf of van een universiteit.

VERTROUWELIJK

3.2. Ik vind dat België <u>mogelijkheden</u> biedt aan high-tech entrepreneurs omwille van: *Duid door middel van een "√" aan tot op welke hoogte de volgende uitspraken van toepassing zijn.*	Volledig akkoord	Akkoord	Noch akkoord Noch oneens	Oneens	Volledig oneens
1. Onwikkelde transportnetwerken.	❒	❒	❒	❒	❒
2. Ontwikkelde nutsvoorzieningen (utilities).	❒	❒	❒	❒	❒
3. De kosten van nutsvoorzieningen (utilities).	❒	❒	❒	❒	❒
4. Ontwikkelde communicatienetwerken.	❒	❒	❒	❒	❒
5. De kosten van communicatie.	❒	❒	❒	❒	❒
6. Aanwezigheid van commerciële & professioniële netwerken.	❒	❒	❒	❒	❒
7. De kosten van commerciële & professioniële netwerken.	❒	❒	❒	❒	❒
8. Aanwezigheid van analisten gespecialiseerd in High-Tech ontwikkelingen.	❒	❒	❒	❒	❒
9. Een meertalige en multiculturele bevolking.	❒	❒	❒	❒	❒
10. De inkomstenbelasting voor personen.	❒	❒	❒	❒	❒
11. De inkomstenbelasting voor bedrijven.	❒	❒	❒	❒	❒
12. De sociale zekerheid en welzijnszorg.	❒	❒	❒	❒	❒
13. De administratie in overheidsdepartementen .	❒	❒	❒	❒	❒
14. Het overheidsbeleid.	❒	❒	❒	❒	❒
15. De aanwezigheid van overheids/publieke fondsen voor R&D.	❒	❒	❒	❒	❒
16. Technologiepolen/Wetenschapsparken.	❒	❒	❒	❒	❒
17. Administratie van intellectuele eigendomsrechten en patenten.	❒	❒	❒	❒	❒
18. De kost om intellectuele eigendomsrechten te beschermen en om te patenteren.	❒	❒	❒	❒	❒
19. Het aantal afgestudeerden in wetenschappen en technologie.	❒	❒	❒	❒	❒
20. Uitwisselingen tussen universitaire/onderzoekslabo's en de industrie.	❒	❒	❒	❒	❒
21. Technologie incubatoren.	❒	❒	❒	❒	❒
22. Netwerken binnen de industrieën.	❒	❒	❒	❒	❒
23. Toegepast onderzoek aan hoger onderwijs instellingen.	❒	❒	❒	❒	❒
24. Sectoriële R&D.	❒	❒	❒	❒	❒
3.3. Ik bechouw mijn bedrijf als een TBSF <u>en</u>:					
1. Ik vind van mijzelf dat ik ondernemerstalenten heb.	❒	❒	❒	❒	❒
De voornaamste motivatie om een eigen bedrijf op te richten is					
↳ 2. het ontwikkelen van een idee.	❒	❒	❒	❒	❒
↳ 3. om eigen baas te zijn.	❒	❒	❒	❒	❒
↳ 4. om meer geld te verdienen.	❒	❒	❒	❒	❒
↳ 5. om professioneel actief te zijn.	❒	❒	❒	❒	❒
↳ 6. de aantrekking voor risico.	❒	❒	❒	❒	❒
7. Een eigen bedrijf oprichten is een goede ervaring die ik wil overdoen.	❒	❒	❒	❒	❒
3.4 Mijn doelstellingen bij het begin van de ontwikkeling van mijn TBSF waren:					
1. De bestaande producten/diensten verbeteren.	❒	❒	❒	❒	❒
2. De bestaande werkwijzen verbeteren.	❒	❒	❒	❒	❒
3. Nieuwe producten ontwikkelen.	❒	❒	❒	❒	❒
4. Nieuwe werkwijzen ontwikkelen.	❒	❒	❒	❒	❒
5. Nieuwe diensten ontwikkelen.	❒	❒	❒	❒	❒
6. De organisatorische structuur veranderen/verbeteren.	❒	❒	❒	❒	❒
7. Het systeem van geïntegreerd beheer veranderen/verbeteren.	❒	❒	❒	❒	❒
8. Het personeel opleiden.	❒	❒	❒	❒	❒
9. Het personeelsverloop tegengaan.	❒	❒	❒	❒	❒

BEDANKT VOOR UW SAMENWERKING !

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9.3. Appendix - The contribution of universities to employment growth

Table A.6.1: Employment growth estimation results (with test of robustness)

Dependent variable: Absolute growth of employment (ΔEMPL)					
Regression results		1	2	3	4
Constant	*C*	-12.621 *(-1.41)*	-19.026** *(-1.98)*	-8.876 *(-0.86)*	-19.877* *(-1.74)*
Company-specific characteristics					
Number of employees (beginning of the analysed period)	EMPLDEB	0.732*** *(3.05)*	0.746*** *(3.15)*	0.635*** *(2.69)*	0.702*** *(2.91)*
Age of the company	AGEC	0.179 *(0.33)*	0.391 *(0.71)*	0.410 *(0.70)*	0.343 *(0.59)*
Industry					
Aerospace and Instruments	AEROINST	10.113 *(1.10)*	8.623 *(0.95)*	9.199 *(1.03)*	10.123 *(1.10)*
Computer	COMP	8.015 *(0.96)*	11.065 *(1.31)*	9.992 *(1.21)*	8.044 *(0.94)*
Electronic	ELECTRO	8.949 *(1.08)*	10.557 *(1.28)*	10.100 *(1.26)*	8.443 *(1.02)*
Pharmaceutical	PHARMA	20.693*** *(2.55)*	18.735** *(2.31)*	18.915** *(2.34)*	21.918*** *(2.61)*
Financial characteristics					
Authorized Capital ($x10^{-6}$)	*AUTHOCAPM*	-4.36*** *(-4.55)*	-4.38*** *(-4.62)*	-4.02*** *(-4.30)*	-4.29*** *(-4.46)*
Type of company					
University spin-off	*UNIFSPIN*		8.987* *(1.72)*		
Origin of the innovative idea					
Personal idea	*INDEP*			-8.839 *(-1.40)*	
Idea from business experience	*BUSIEX*			-6.384 *(-0.95)*	
Idea from business research	*BUSIR*			20.915** *(2.35)*	
Idea from academic research	*UNIVR*			-2.905 *(-0.34)*	
Founder-specific characteristics					
University or Master	*UNIFMASTER*				8.393 *(1.31)*
Ph.D. or Post-Ph.D.	*PHDPOSTPHD*				4.401 *(0.55)*
Test of robustness					
Survey by mail or interview	*SURVEYTYPE*	-1.797 *(-0.32)*	-0.243 *(-0.04)*	-1.910 *(-0.34)*	-1.419 *(-0.25)*
R^2		0.359	0.383	0.432	0.375

Note: Data on 87 high-tech companies. * Indicates the parameters that are significant at a 10% probability threshold, ** 5% probability threshold and *** 1% probability threshold. Econometric method: OLS T-Statistics in parentheses.